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[THIRD SERIES.]

ART. XX.—*The Hot Springs and Geysers of the Yellowstone and Firehole Rivers;* by F. V. HAYDEN. With maps.*

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IN an article, in the February number of this Journal, we closed with a brief description of the mud springs six miles below the Yellowstone Lake. The term Yellowstone Basin is sometimes applied to the entire valley; but the basin proper comprises only that portion enclosed within the remarkable ranges of mountains, which give origin to the waters of the Yellowstone, south of Mount Washburn and the Grand Cañon. The range, of which Mount Washburn is a conspicuous peak, seems to form the north wall or rim, extending nearly east and west across the Yellowstone, and it is through this portion of the rim that the river has cut its channel, forming the remarkable falls and the still more wonderful cañon. This basin is about forty miles in length from north to south, and on an average thirty miles in width from east to west. From the summit of Mount Washburn a bird's eye view of the entire basin may be obtained, with the mountains surrounding it on every side, without any apparent break in the rim.

This basin has been called, by some travelers, the vast crater of an ancient volcano. It is probable that during the Pliocene period, the entire country drained by the sources of the Yellowstone and the Columbia was the scene of as extensive volcanic activity as that of any portion of the globe.

* The charts accompanying these articles were prepared by Mr. E. Hergesheimer, a most accomplished topographer connected with the U. S. Coast Survey.

It might be called one vast crater made up of thousands of smaller rents and fissures, out of which the fluid interior of the earth fragments of rocks and volcanic dust have been erupted in unlimited quantities. Hundreds of the nuclei or cones of these volcanic vents are now remaining, some of them rising to a height of ten thousand to eleven thousand feet above the sea. Mounts Doane, Langford, Stevenson, and more than a hundred other peaks, may be seen from any high point on either side of the basin, each of which was once a center of eruption. Indeed the hot springs and geysers of this region are only the closing stages of that wonderful period of volcanic action, which began in Tertiary times. In other words, they are the escape-pipes or vents for those internal fires which were once so active, but are now gradually dying out. The evidence is clear that, ever since the cessation of the more powerful volcanic action, these springs have been the escape pipes, and have been declining to the present time, and will continue to do so until they entirely cease. The charts accompanying these articles will enable the reader to form a clear conception of the position and number of the most important springs in this basin; but an equal number of the dead and dying springs have been omitted.

Even at the present time there are connected with these manifestations of internal heat, earthquake phenomena, which are well worthy of attention. While we were encamped on the northeast side of the lake, near Steamboat Point, on the night of the 20th of July, we experienced several severe shocks of an earthquake, and these were felt by two other parties, fifteen to twenty-five miles distant, on different sides of the lake. We were informed by mountain men, that earthquake shocks are not uncommon, and are, at some seasons of the year, very severe; and this fact is given by the Indians as the reason why they seldom or never visit this portion of the country. I have no doubt that if this region should ever be settled and careful observations made, it would be found that earthquake shocks are of very common occurrence.

The lake itself is about twenty-two miles long and averages ten or fifteen miles in width. Our soundings show it to have an unusual average depth, though the greatest depth which we were able to find, after a careful series of observations, was about three hundred feet. It is fed by the snows that fall upon the lofty ranges of mountains that surround it on every side. It is the most beautiful sheet of water I have ever seen in the West. The clear green shading, with the deep ultramarine hue of the waters, adds not a little to the effect of the scene. The lake has, at all seasons, nearly the temperature of cold spring water. Its height above the sea level is about 7,427 feet. We were able to discover but one species of fish, a trout weighing from

one to three pounds each. They are very abundant; but five out of six of them were infested with a singular parasitic worm, which is found in the abdominal cavity, or interwoven in the muscular portions in sacs or cysts, or sometimes in the gills. Dr. Leidy has described these worms under the name of *Dibothrium cordiceps*. It is possible that this diseased condition of the fish is caused by the proximity of the hot springs, which are abundant all around the shore of the lake and sometimes extend far out into the waters.

We cannot at this time present a full description of a lake which would of itself furnish the material for an extended article. We may remark, in passing, that we regard the lake basin as due in part to erosion. All along its margin are high banks and terraces composed of a modern stratified deposit, passing up into an aggregation of sand, pebbles, &c., which is not unfrequently cemented into a tolerably firm conglomerate. These deposits, which are made up of eroded volcanic rocks, have in some instances the white appearance, and somewhat the composition, of the Pliocene clays, marls and sands of the other lake-basins along the Missouri and the lower Yellowstone. In the northern portion of the basin, these deposits reach a thickness of three hundred to six hundred feet, and must be of the later Pliocene age, and perhaps extended down to the present time. The two lakes were then connected, although probably never completely united. The belt of mountains that separated them was about four miles in width. I have estimated that, since the period of volcanic activity, the depth of the lake has been about five hundred feet greater than at present, the shore line being then high up on the sides of the surrounding mountains. During the time of the greatest volcanic action, the waters must have covered the loftiest peaks; for many of them are composed of the breccia or conglomerate in a regularly stratified condition. This breccia surrounds the highest volcanic cones or nuclei, as Mounts Doane, Stevenson, &c. The area occupied by the lake is now gradually but very slowly diminishing.

On the shore of the southwest arm of the lake is an interesting group of hot springs, which extend along the margin, covering a belt about three miles long and nearly a mile in width. These springs have built up a series of beds, or strata, about 25 feet thick, in the aggregate, composed of laminæ of silica, which have been worn into a bluff wall by the waves. The shores are covered with the decomposed siliceous crust, so that it looks as if it were covered with the fragments of washed sea-shells.

Many of the springs, which might be called pulsating springs, are in a constant state of quite violent ebullition, but rise and fall every second or two, and, with each pulsation, throw out a small quantity of water. Quite a pretty symmetrical funnel-

shaped crater is formed with a circular rim varying from a few inches to several feet in diameter. Some of these funnel-shaped

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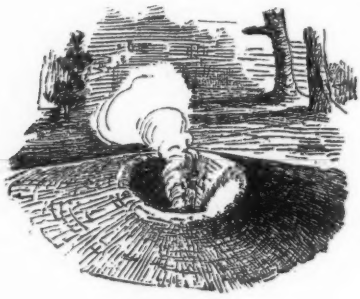


Hot Spring.

chimneys extend out into the lake several feet, and the hot spring deposits may be seen through the clear depths for fifty yards. Bubbles may be seen on the surface of the water some distance from the shore in many spots and show the presence of a spring beneath.

The same variety of colors, quiet springs, mud springs, old ruins, &c., that we have before described, occur here. No geysers were observed, but the group of mud springs keep up a constant thud-like noise, which can be heard with great distinctness for half a mile.

On the east and northeast sides of the lake are a number of groups of living or dead springs. High up on the sides of the mountains are two quite extensive patches of the siliceous deposit, which look in the far distance like an immense bank of snow. They are called by the mountaineers, brimstone basins. The large double basin on the southeast arm was once covered with hot springs, though at the present time, there is no water there with temperature above ordinary spring water. Great quantities of sulphur are mingled with the silica, and hence the name.

At Steamboat Point there are two vents which keep up a constant pulsating noise like a high-pressure engine on a river steamboat. Columns of steam are thrown out at each pulsation to the height of 100 feet or more. Hundreds of small simmering vents are scattered all around; dead and dying springs in great numbers can be seen along the shores of the lake, and high up among the foot hills of the mountains, a mile or two from the lake. One of the most conspicuous of these great white hills, seen from all sides of the lake, is called Sulphur Mountain: it is located on the side of the mountains at the north end of

the lake. The summit of this deposit rises about 600 feet above the lake; it is the remains of one of the most interesting group of springs in the vicinity; there are now many steam vents lined with a brilliant coating of sulphur. The deposit is from 50 to 150 feet in thickness, and when not mingled with sulphur, is as white as snow. Silica predominates over all other materials; but it is much variegated by oxide of iron, sulphur, &c. At the foot of the mountain, near the margin of Pelican Creek, a few springs issue from beneath the crust with a temperature from 150° to 180°, but this great group may now be regarded as extinct.

We will now leave the Yellowstone Basin, and, pursuing a westerly course, make our way over the high range, or divide, into the great Geyser Basin of the Firehole river, a branch of the Madison Fork. The mountains that surround the Yellowstone Basin are of the same character as those which extend down the branches of the Madison and Gallatin Forks for thirty miles; and not until then do the sedimentary or granitic rocks appear to any extent. Immense quantities of obsidian also are found on both sides of the range. Little lakes, varying in size from the diameter of a few hundred yards to four or five miles, are scattered all about the sources of the Missouri, Yellowstone and Columbia. Some of them are situated on the very summits of the mountains, ten thousand and eleven thousand feet above the sea.

Traveling in this region is attended with great difficulties, on account of the fallen timber. The uplands, as well as the lowlands, are covered with a dense growth of pines, the majority of which have a trunk not over six to twelve inches in diameter, but run up to a height of 100 to 150 feet, as straight as an arrow. These pines often grow so thickly together, that, for miles, it is very difficult to find space between them for the passage of our pack animals. Almost every year the autumnal fires rage among these dense forests, destroying the trees; and then come the strong winds that lay them down in every direction. We have traveled for thirty to fifty miles over a perfect network of these fallen pines, from three to six feet high, requiring great ingenuity and labor to make our tortuous way among them.

In crossing the main divide between the drainage of the Yellowstone and the Madison, we first strike the sources of the branch named, on the chart of the Lower Geyser Basin (accompanying this paper), the East Fork. Every few miles we meet a group of dead or dying springs. Very few of these contain much water at the present time, but steam was issuing from hundreds of vents. There was one locality, covering several acres, that presented one of the most beautiful of scenes. The

entire area was covered thickly with conical mounds of various sizes, ranging in diameter from a few inches to a hundred feet or more, and these cones or hillocks were full of orifices, from which streams were issuing. All these little chimneys or orifices were lined with the most brilliant crystals of sulphur, and when the heated crust was removed, we found the underside adorned in the same manner. The basis of the deposit was silica, as white as snow; but it was variegated with every shade of yellow from sulphur, and with scarlet or rose color from oxide of iron. In the distant view the appearance of the whole country may be not unaptly compared to a vast limekiln in full operation. The east branch of the Madison is almost entirely fed by water from the hot springs, and its temperature is 60° or 80° all the time. The vegetation that grows along its branches and in the stream itself is a marvel of luxuriance.

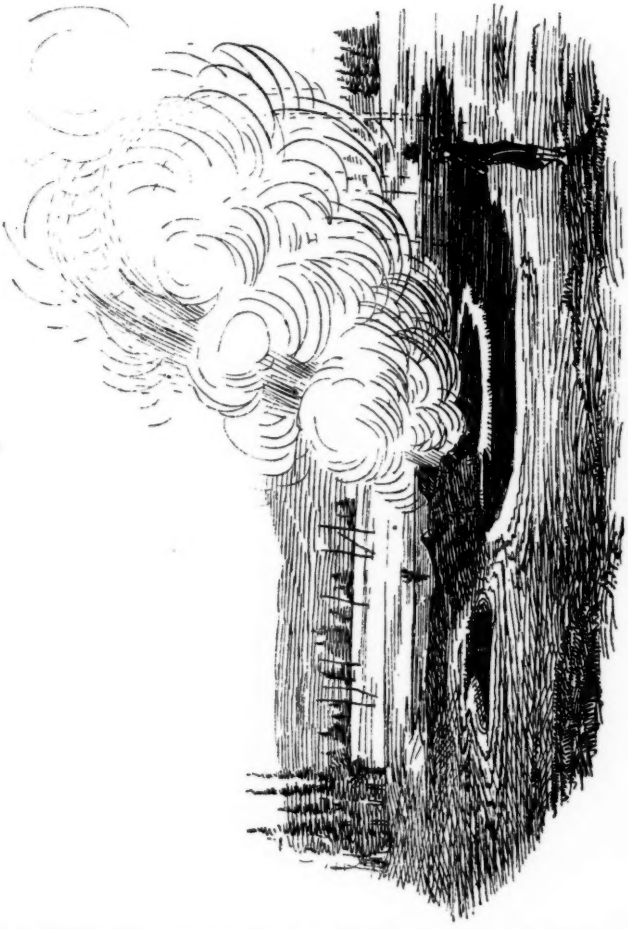
The mountains that enclose the valley on either side are composed of basalt and obsidian. The valley itself, which varies from half a mile to a mile in width, is underlaid with hot-spring deposits. The surface waters pour in abundantly from numerous springs, at the base of the hills on either side, and cover the valley, so that it is one great marsh or bog. Among the foot hills are a number of old ruins, or groups of dead and dying springs, with a few steaming sulphur vents remaining to mark the dying stages.

As we proceed down the valley, toward the junction of the East Fork with the main Madison, the springs grow more abundant, and we soon come to the great basin of the Firehole, in which the most powerful geysers are found.

First, before reaching the valley of the Firehole, there is a large group of springs, on both sides of the East Fork (see chart). Here there are no true geysers, but great numbers of boiling and quiet springs, having basins varying in diameter from a few inches to fifty feet, and temperatures ranging from 100°, to 197° F. The elevation here is such that the boiling point is from 192° to 196° F. Only the more important springs are located on the chart, a large number of dead or dying ones being not considered worthy of attention.

A broken range of hills, forming a kind of ridge, extends down between the valleys of the Firehole and East Fork. Near its terminus it is broken into several isolated butes, which are largely made up of old hot spring material, as well as basalt. Indeed, the igneous rocks on either side of both the valleys show plainly that during the time that the volcanic forces were dying out, the hot-springs were in their most active condition, forming very thick deposits, which made up a large portion of the mountain.

From the large group of springs on the East Fork, we passed, between the isolated buttes, to the valley of the Firehole, where the principal springs and geysers are located. The entire valley, averaging about three miles in width, is covered with the sili-

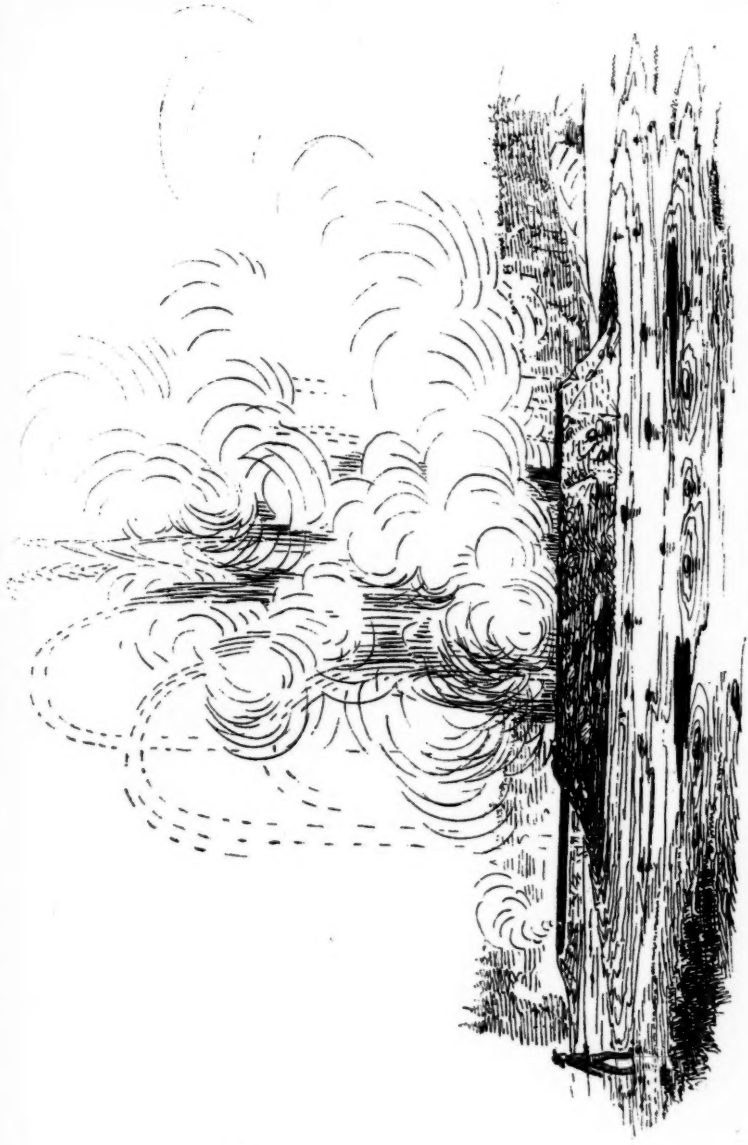


HOT SPRING BASIN.

ceous crust as white as snow. Among the dense pines in the foot hills, and even quite high on the mountain side, a column of steam, rising above the tops of the trees, reveals the location of a spring or a steam vent. As we came out into the level open plain of the Firehole valley, the elevated mounds and

numerous columns of steam revealed to us where the most important groups were located. It will be seen on the chart that all these groups, and nearly all the springs, occur along the valleys of the streams, and for the most part very near their banks. On the east side of the valley are scattered groups of springs, the aggregated waters of which form quite large streams. By the side of the largest stream we encamped for two days, making use of the water for drinking and cooking purposes. Some of these springs have the most beautifully scalloped rims, with the inner and outer surfaces covered over with delicate bead-like elevations. The basins vary in diameter from a few inches to one hundred feet. Some of them have nearly circular rims, with funnel-shaped orifices, and are filled with water up to the very margin, which is so transparent that we could look down into the clear depths for five to forty feet and see the smallest tubercle upon the surface. The funnel-shaped orifice or basin usually extends down until it closes up to a very narrow fissure, and then extends on below to an unknown depth.

In the Lower Geyser Basin, although there are many groups of most interesting springs, none of them can rank as geysers of the first class. Over an area of about three miles in width and five in length, the surface seems to be literally riddled with the orifices of active, quiet, dying and dead springs. There must be, at least a thousand of them; only the most important are noted on the chart. Some of them may be called true geysers having rather regular periods of activity, and throwing up columns of water from two to six feet in diameter to the height of 15 to 30 feet. One geyser, with quite a small orifice, played every fifteen minutes or so, sending up a column of water 20 to 30 feet high. A large number of the springs were in a constant state of violent ebullition, throwing the water up two to four feet. Occasionally an unusual impulse was given to the column, sending it up 10 or 12 feet. One of the most remarkable of the springs in this lower basin had built up for itself a cistern, which for beauty and elaborateness would compare well with those of the springs on Gardiner's river. We called it the *architectural fountain.* The whole basin is about 150 feet in diameter. Near the center is the rim of the spring, which is about 25 feet in diameter; the water is in constant agitation, occasionally spouting up a column of water, like an artificial fountain, and filling up the reservoirs and the sides for a radius of 50 feet or more. The siliceous accumulation made by this spring descends for several hundred feet in innumerable semi-circular steps varying from one-fourth of an inch to two inches in height, and is exquisitely beautiful in all its details. When in active operation a column of water is thrown 30 to 60 feet high, when the waters spread over a radius



ARCHITECTURAL FOUNTAIN.

of fifty feet, filling the numerous reservoirs that surround the immense rim of the basin. There were other funnel-shaped basins with elegantly scalloped rims, which were covered all over the inner side, to the depth of 10 to 20 feet, with bead-like tubercles of silica. Sometimes these siliceous beads were arranged in large numbers like Fungia corals, or like the heads of cauliflowers.

In the Firehole Basin, silica predominates in the deposit, and so far as we could determine there was very little, if any, lime. Sulphur occurs in very small quantities in the lower basin, although there were two or three springs the orifices of which were lined with it.

A short distance from this beautiful geyser is a remarkable group of *mud springs*. One of them has a basin fifty feet in

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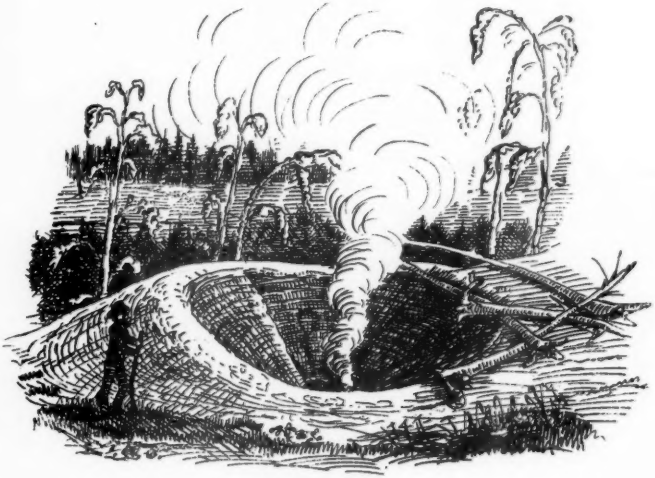
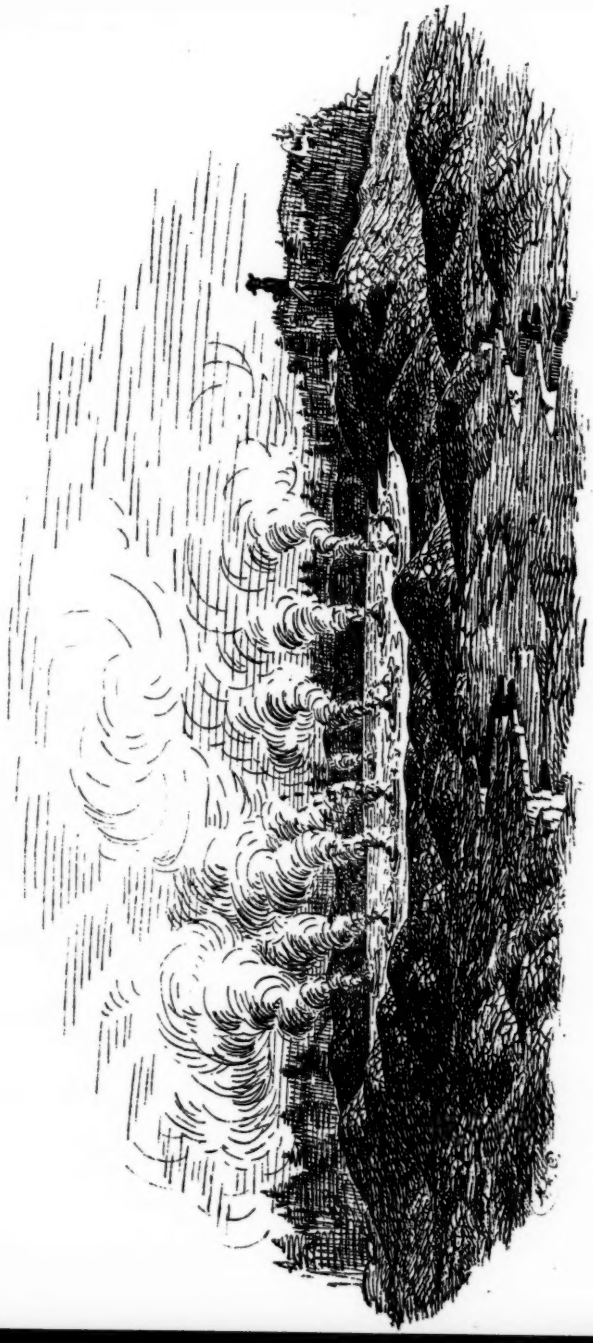


[MUD GEYSERS.

diameter, which is covered over thickly with puffs, like an immense cauldron of thick hasty-pudding. The exact symmetry of these puffs, their uniformity of size and the fineness of the material render them exceedingly beautiful; and there is among them every shade of color, from a bright scarlet to the most delicate pink or rose, with a base as white as snow. The white siliceous clay, when dried, has the appearance of the finest meerschaum. The most fastidious manufacturer of porcelain ware, would go into ecstacies over this magnificent bed of mortar, that has perhaps been worked and re-worked for many thousands of years.



5. Mud Puffs.

These springs occur in small groups all over the basin, and are often in close proximity to geysers or to perfectly clear quiet springs. They are found in every stage, from simply turbid water, through all grades of consistency, to thick stiff mud, through which the gases force themselves with a suppressed thud-like sound. Each of these mud springs probably commenced as a geyser or at least as a boiling spring. The water is at first clear, then becomes turbid, and grows gradually thicker until the heat dies out.

About half of the springs are in the last stage of action. They have been either geysers, or very active boiling springs, as is shown by the character of their basins; but now their temperature is diminished to 150° and all the way to 80°. When the temperature diminishes to 160°, oxide of iron is thrown down, and they become what are marked on the charts as iron springs. A thick coating of a dull iron-rust color is deposited all over the inner side of the basin, and over the surface where the water flows. This coating in the old springs becomes broken up, so that it is suspended all over the sides of the springs like rotten mouldy fragments of leather. The iron is undoubtedly held together by vegetable matter. When these springs entirely dry up, these leathery fragments are blown about the surface in every direction by the winds.

In the vicinity of the active geysers, the surface over which the surplus water from an eruption flows is sometimes covered, to the thickness of two to four inches, with a substance which appears to the touch like jelly or pulp. All over the surface there are irregular depressions with sharp raised edges, like the inner surface of a cow's stomach. The colors are varied, being usually a white base with every variety of scarlet, pink or rose color, with brilliant shades of green.

Another interesting feature was the quantity of incrusted and silicified wood found scattered about the springs. Very frequently the pine trees, which are abundant in the vicinity, have fallen across the basin of a geyser, or an active boiling spring. The wood becomes permeated with the hot water holding silica in solution, and soon becomes like paper pulp. When the spring dries up, the wood remains in the basin thoroughly silicified and incrusted with a coating of silica. The entire cellular structure is permeated with the silica, and the process of petrifaction is most clearly shown. Into one of the large hot springs, about fifty feet in diameter and twenty feet deep, a living pine tree had been blown by the wind, and all the branches, leaves and cones were completely incrusted over and partially permeated by the silica.

Up the Firehole river about ten miles, there is the Upper Geyser Basin, where the great geysers are found.

In the Lower Geyser Basin on both sides of the Firehole, even up among the foot hills of the mountains on either side, are springs in a state of greater or less activity, and upon the very summits of the mountains is here and there a steam vent. But none of the Grand Geysers are found here. For four or five hours in the early morning, this valley presents one of the most interesting pictures that can well be imagined: columns of steam are rising from a thousand vents, completely shrouding the valley as with a dense fog. A view of the city of Pittsburg from a high point would convey some idea of the appearance of this valley, except that in the former case the dense black smoke arises in hundreds of columns, instead of the pure white feathery clouds of steam.

The Upper Geyser Basin is located very near the source of Firehole river, and between it and the Lower Geyser Basin there is an interval of about five miles in which the hills come close to the river on both sides, and the springs occur only in small groups. Although possessing some interest, yet there were so many others in the region that they did not attract much attention. The valley, as well as the bed of the creek, is covered with old deposits, showing clearly that these springs have been successively breaking out, reaching their culminating period of activity, and then dying out, ever since the Pliocene era. Above this woody and rocky interval, the valley again expands, and a branch comes in from the southwest,

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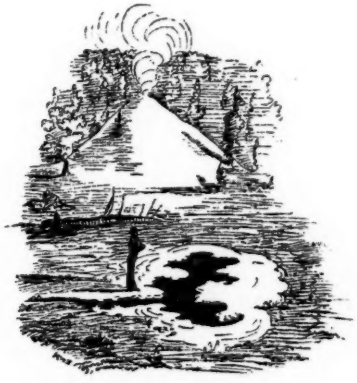

STEAM SPRING AND CONE.

which we call Iron Spring Creek, on which are located many more springs, as the chart indicates. This stream receives its name from the vivid yellow and pink clays, on both sides, from mouth to source. Ascending the Firehole, we find the surface, on both sides of the river, covered with a thick siliceous

crust, and completely riddled with springs of every variety. Quiet springs, with basins varying from a few inches to a hundred feet in diameter, are distributed everywhere. Some high pyramidal cones, with steam issuing from the summits, indicate the last stages of what were once important geysers.

Near the center of the basin, which is about two miles long and half a mile in width, there is one of the most powerful geysers of the basin. During our short visit of two days it operated twice. Our camp was pitched within a few yards of it. The preliminary warning was indicated by a tremendous rumbling, which shook the ground all around us with a sound like distant thunder. Then an immense mass of steam burst out of the crater as from an escape pipe, followed by a column of water eight feet in diameter, and rising by steady impulses to the height of two hundred feet; I can compare the noise and excitement which it produced only to that of a charge in battle. This wonderful fountain continued to play for the space of fifteen minutes, when the water gradually subsided and settled down in the crater, about two feet, and the temperature slowly diminished to 150°. There are here two separate basins, one of which is in a constant state of violent agitation, while the other plays only at intervals of about thirty-two hours; and although, so far as the eye could detect, there was a partition of not more than two feet in thickness between them, neither of them seemed to be affected by the operation of the other. The decorations about these springs were beautiful beyond anything I had ever seen in nature. The most delicate embroidery could not rival them in their wonderful variety and complexity. The surface within and without was covered over with little tubercles of silica, which had a smooth enameled appearance like the most delicate pearls; down on the sides of the basin were large rounded masses like corals, formed entirely of silica. There was one spring with a small elevated crater about two feet high, which threw up a small column of water, about twelve feet high, by continued impulses, like the movements of a saw, and thus it received the name of the Sawmill Geyser. There were probably from twenty to fifty geysers of greater or less importance in this valley; and it is quite possible that some of the springs placed in the quiet class operated at times as first class geysers. There were also the Grotto Geyser and Castle Geyser. The crater of the latter is about 40 feet in height, and one hundred and fifty to two hundred feet in diameter at its base; it was built up of thin layers of the silica, which rise, much like steps, to the chimney on the summit, which is about ten feet high. Clouds of steam issue constantly from this chimney, and every few moments a column of heated water is thrown up fifteen to twenty-five feet.

But the most accommodating, and, in some respects, the most instructive geyser in this basin was called by Messrs. Langford

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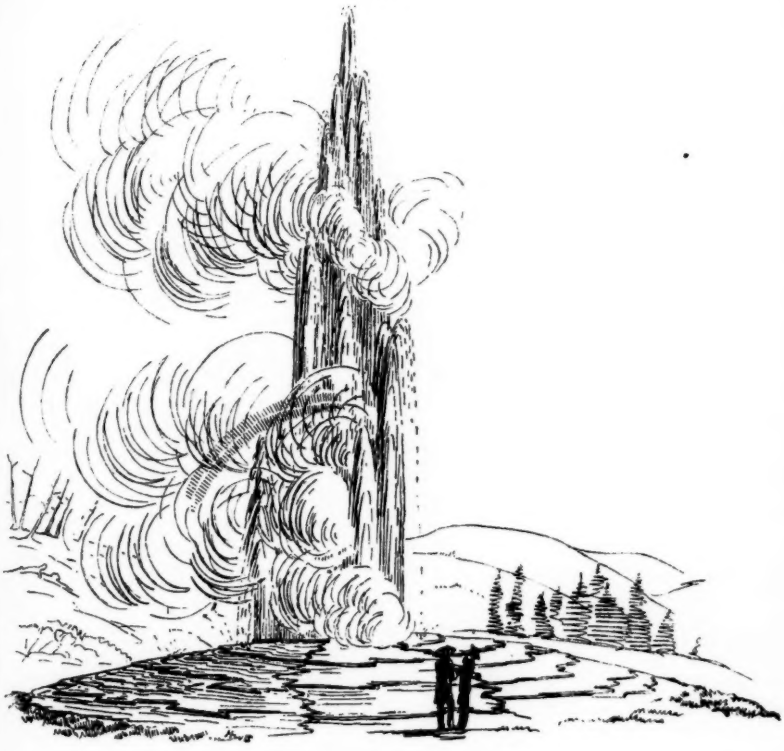


GIANT GEYSER.

and Doane "Old Faithful." During our stay it operated every hour, throwing up a column of water six feet in diameter from one hundred to one hundred and fifty feet. When it is about to make a display, very little preliminary warning is given. There is simply a rush of steam for a moment, and then a column of water shoots up vertically into the air, and by a succession of impulses is apparently held steadily up for the space of fifteen minutes, the water falling directly back into the crater and overflowing in large quantities. It then ceases, and with a rush of steam for a few seconds closes the display for the time. Words can convey but an inadequate conception of the intense excitement which the scene produces upon the mind.

Night and day some of the geysers are in operation continually, and, at certain periods, several of them perform at the same time.

The two kinds of deposits in these regions, the calcareous and siliceous, have been mentioned in the preceding descriptions. According to analyses by Dr. Peale, Chemist of the U. S. Geological Survey, the springs on Gardiner's river which we call the White Mountain Springs deposit carbonate of lime mostly. There is present also sulphate of magnesia, chloride of lime, sulphate of soda and a little silica. In the deposits of the Firehole Basin not a trace of lime could be detected, but about 85 per cent of silica, 11 per cent of water and the remainder mostly chloride of magnesia; and only a slight trace of lime was found in the water. In but one locality west of the lake, Col. J. W. Barlow found a calcareous deposit. There are, scattered over the great area, about forty by fifty miles in extent, a few patches of the sedimentary rocks, and it is most probable that underneath the deposit of this small group of springs, there are portions of the Carboniferous limestone.

So far as we could ascertain, in all the deposits of the Yellowstone Basin proper, and in the Firehole Basin, silica is the dominant constituent. The springs are, with very few exceptions, and those not important, near the borders of the streams below any beds of limestone. It is quite possible that underneath the vast masses of volcanic material, which compose the mountains on every side, the sedimentary rocks exist, but I am disposed to believe that they occur only in isolated and much restricted patches, if at all.

We may therefore state, in general terms, that the great hot spring region of the sources of the Yellowstone and Missouri rivers is covered with rocks of volcanic origin, of comparatively modern date.

In this article I have been able to present only a few of the wonderful and most attractive features of this unique region. A bill has been introduced into Congress which has for its purpose the setting apart of this wonderland as a great National Park for all time. We have, as a precedent, a similar action with regard to the Yosemite valley, and this noble act has met with the hearty approval of the people. The speedy passage of this bill, which will prevent squatters from taking possession of the springs and destroying the beautiful decorations, will also meet with the cordial approval of all classes. We hope that before this article is published to the world the act will have become a law.

ART. XXI.—*On the Electrolysis of the Substituted Derivatives of Acetic Acid. Preliminary Notice;* by Dr. G. E. MOORE.*

MORE than a year ago the writer undertook, at the suggestion of Prof. Hermann Kolbe, the study of the phenomena attending the electrolysis of monocyanacetic acid. The question for whose solution the work was undertaken is the following:

It is well known that Kolbe obtained by the electrolysis of acetic acid a gaseous product, which he held to be identical with the univalent radical *methyl*. According to the generally received opinion the products of the action of chlorine, iodine, and bromine, etc., on acetic acid, stand in the very simple relation to the parent substance, that one or more atoms of hydrogen in the *methyl* group are replaced by a corresponding number of atoms of chlorine, iodine or bromine. According to analogy, therefore, the electrolysis of these substituted acids should result in the formation of substances which represent such substituted radicals. Prof. Kolbe formulated this reaction as follows:

$$2\left.\begin{matrix}H_2\\CN\end{matrix}\right\}C\left[CO\right]OH+H_2O=2\left(\left.\begin{matrix}H_2\\CN\end{matrix}\right\}C\right)'+2CO_2+H_2O+H_2,$$

in other words, the univalent radical *monocyan methyl* $\left(\left.\begin{matrix}H_2\\CN\end{matrix}\right\}C\right)'$ was to be expected, a substance which would probably be either a gas or a readily volatile fluid.

For the purpose of answering this question, a quantity of rather more than 200 grm. of pure monocyanacetic acid was prepared, and purified from every trace of chlorine by a very tedious fractional crystallization of the lead salts of the mixture of monochlor- and monocyan-acetic acids first obtained.

With this material the electrolysis was performed in the month of December, 1870. The result obtained was decidedly *negative;* the expected substance could not be detected among the products of decomposition, and the question for whose solution the investigation was originally undertaken was therefore to be considered as settled.

It appeared desirable, nevertheless, to subject the products of the electrolysis to a more thorough examination. They are of very diverse nature, and their examination is by no means completed; as, however, temporary postponement of the work has become necessary, it may not be without interest to communicate a few of the more interesting results already obtained; all analytical data are reserved for a future detailed communication.

* Communicated, in substance, to the Chemical Society of Berlin, at the sitting of May 22d, 1871.

If a concentrated neutral solution of pure potassium monocyanacetate, free from chlorine, be subjected to the action of the current from six Bunsen's elements, a voluminous evolution of gas ensues at the positive pole, which is, with the exception of a slight residue, soluble in potash solution. The unabsorbed portion appears to be, after the removal of a trace of gases absorbable by bromine, an entirely indifferent gas, probably nitrogen. The strongly acid solution in the positive cell, was, after the completion of the reaction, repeatedly shaken with ether and the latter distilled from the water-bath. The residue of the distillation, a deliquescent acid substance, was dissolved in a large volume of ether, the solution rendered neutral by agitation with the least possible quantity of potash solution, filtered and the ether distilled off from the water-bath. There remained a brownish residue, solid at ordinary temperatures, which agreed in its crystalline texture and other external properties, as well as in its fusing point (37°·8 C.), with ethylene cyanide $C_2H_4(CN)_2$. When boiled with a concentrated potash solution it evolves ammonia, and leaves a residue in which, by means of its suffocating vapor and reaction with ferric chloride, ethylene succinic acid may easily be detected.

The course of this phase of the decomposition may therefore be represented by the following equation:

$$2\begin{matrix}CH_2CN\\ |\\ CO.OH\end{matrix}+H_2O=\begin{matrix}CH_2CN\\ |\\ CH_2CN\end{matrix}+2CO_2+H_2O+H_2,$$

precisely analogous to the reaction by which, during the electrolysis of potassium acetate *dimethyl* $\begin{matrix}CH_3\\ |\\ CH_3\end{matrix}$ is obtained.

The study of the associated products of the electrolysis being still incomplete, I abstain from a further development of the theoretical bearings of the facts already communicated until the missing data can be obtained.

As far as studied the reaction affords a very clear and positive evidence regarding the constitution of ethylene; it proves by a simple synthesis that this body is formed by the direct union of two methylene groups, and, that its formula should be written, in accordance with what is now the general usage $\begin{matrix}CH_2\\ |\\ CH_2\end{matrix}$ and not, as it is still occasionally written, $\left(\begin{matrix}CH_3\\ H\end{matrix}\right\}C)''$, or, what is the same thing, $\left(\begin{matrix}CH_3\\ |\\ CH\end{matrix}\right)''$.

It is my intention to extend this investigation to the doubly and triply substituted acetic acids, and, as the corresponding

cyanogen derivatives are still unknown, I shall try if it be possible to obtain a similar series of reactions among the chlorine derivatives. Monochloracetic acid should give ethylene dichloride $\begin{matrix}CH_2Cl\\ |\\ CH_2Cl\end{matrix}$; and, by a precisely analogous reaction, we might expect from the electrolysis of dichloracetic acid acetylene tetrachloride $\begin{matrix}CHCl_2\\ |\\ CHCl_2\end{matrix}$. In the same manner the electrolysis of trichloracetic acid would probably yield dicarbon hexachloride $\begin{matrix}CCl_3\\ |\\ CCl_3\end{matrix}$.

ART. XXII.—*Green Mountain Geology. On the Quartzite;* by JAMES D. DANA.

THE quartzite of the Green Mountain region is the most remarkable of its rock formations. It has a wide distribution along the range, occurring in Connecticut, Massachusetts and Vermont, and some parts of New York adjoining. It is peculiar in the isolation and bold obtrusiveness of its outcrops; for its hills and ridges often rise out from among the other rocks with the look of independence that belongs to an eruptive intruder. While some patches barely show themselves above the general surface, others make mountain ridges or peaks, the summits two thousand feet and more above the sea.

The outcrops are smallest to the south, in Connecticut, and largest in the southern half of Vermont. In the latter region, the quartzite departs somewhat from its habit of isolation, and forms, according to the geological map of Vermont in the Report of 1861, a ridge, with but small interruptions, over one hundred miles in length, rising near Bennington, in Bald Mountain, to a height of 3100 feet.

The quartzite has still another peculiarity in usually cropping out in the vicinity of the great metamorphic limestone of the Green Mountain range, called the Stockbridge limestone; and in largest amount, but not exclusively, near the eastern border of the limestone region. When the conclusion was reached, or assumed, that this limestone was of Lower Silurian age, it was, obviously, a natural inference that the quartzite, in many places manifestly an underlying rock, was the Potsdam sandstone, the great quartz formation of the early Silurian. These views were brought out as parts of one scheme by Professors W. B. and H. D. Rogers in 1841,* the slates between

* Proc. Amer. Phil. Soc., Jan. 1, 1841; also, Trans. Assoc. Amer. Geol. and Nat., 1842, p. 482; and Address before the Assoc. in 1844, Am. Jour. Sci., xlvii, 150, 1844

the Hudson river and the Stockbridge limestone being regarded as in part the Hudson river shales folded and partially metamorphic.

Professor Emmons in his Geological Report (1842), treating of his Taconic system, reversed the order, putting the Stockbridge limestone over the quartzite; but the Taconic slates, lying to the west, with some limestone strata associated with these slates, conformably below both, and making all older than the Potsdam, or the basal rock of the New York series. The fact that, in the New York series below the great Lower Silurian limestones, there were no beds corresponding to the extensive range of Taconic slates, was the prominent reason urged in his Geological Report of 1842 for the pre-Silurian age of these rocks; and the occurrence of fossils (trilobites, proved since to be Primordial) in the Black slate of Bald Mountain (near Chatham Four-corners), unlike any known in the American Lower Silurian, was an additional argument in his Agricultural Report published in 1843.

In the Report of 1842, the Taconic region is made to extend to the western base of the Taconic mountain, and the slates west are called, in the sections (plate xv), Hudson River slates. In that of 1843 the slates all the way to the Hudson river are referred to the Taconic system. Besides this change of view, the order of the strata of the Taconic series is reversed in the latter Report, the quartzite being placed at the bottom; over this, conformably (in some localities), the Stockbridge limestone; next, the schists and slates, to the west; and last, the Black slate of Bald Mountain, the newest of the series; and this order is made consistent with the easterly dip throughout, by supposing, in order, "to assist us in maintaining these views," that the "superior members," or newer rocks, were removed by abrasion to the eastward before they were upturned, and were "thus limited in an easterly direction;" and, besides, the upper strata were probably "scantily extended east and west," "the whole system having been formed in a trough." The quartzite is still made conformable to the limestone, while the black slate is at the other end of the series conformable also. In his American Geology, published in 1855, this order is in the main sustained, the quartzite and associated slates being overlaid conformably by the Stockbridge limestone, this by the "talcose" slate of Graylock, and the Taconic slates to the west; and, finally, the Black slate of Bald Mountain being made Upper Taconic, and the Georgia slates of Northern Vermont being brought into parallelism with it.

Had Professor Emmons made out rightly the relations of the quartzite to the Stockbridge limestone, the argument presented in 1842, and since, for the pre-Silurian age of the Taconic would have been without any foundation worthy of note.

Later geologists have accepted the conclusion that the Stockbridge limestone and the Taconic slates, to the Hudson, make one series of rocks; but they have made all of Lower Silurian age, and the slates older than the Trenton. Logan has referred the beds to the Quebec group on his geological map of Canada. The quartzite, however, is still of undetermined relations, some regarding it as at the base of the Lower Silurian, and Logan placing it at the top.

I propose to state the more important facts which I have observed in connection with the Green Mountain quartzite at a few of its localities, and some of the conclusions which they appear to sustain.

Several sources of uncertainty attend the investigation of the quartzite formation.

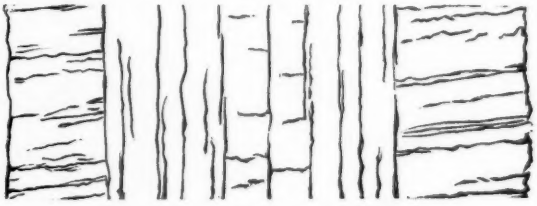
In the first place, there are quartzites of more than one age in New England, west of the Connecticut river. A Helderberg quartzite exists at Bernardston, Massachusetts, in the Connecticut river valley; and it does not differ in characters from much of the Green Mountain quartzite. Another quartzite, of different age, is interstratified with gneiss, about three miles west of Plymouth, Vermont, on the road to Cuttingsville; and the gneiss of the region is apparently the ordinary Green Mountain gneiss. Then there is the great quartzite of the Green Mountain range, whose relation to the quartzite in the gneiss is unascertained. We cannot assume, therefore, that this last is all of one geological age.

Another difficulty in the way of investigation arises from the fact that the quartzite is very generally jointed, and the joints are often so numerous and regular that they are easily mistaken for planes of bedding. The only safe course in all cases was found to be, to doubt as to the bedding unless there were alternate layers differing distinctly in structure or fineness of texture, especially when the divisional planes dip at a high angle. So far as my observation goes, its joints are commonly nearly or quite vertical; while the beds seldom have a greater dip than 45°, and often are nearly horizontal.

The obliteration of the bedding by impulses of lateral pressure is well illustrated in the quartzite near Poughquag,* Dutchess Co., N. Y., where the bedding is beautifully distinct and nearly horizontal. In two or three places, in the course of a long section of the well stratified beds, there are narrow vertical portions, of the whole height of the section exposed, which have lost entirely the bedding, or division into layers, and are divided only by vertical joints. The accompanying sketch illustrates one of them. The jointed vertical strip is only 8 feet wide, and looks a little way off like a dike of igneous rock. Yet it is only a narrow vertical section of the strati-

* Pronounced as if spelt *Poquaig*.

fied quartzite, in which, under the lateral pressure, fractures were produced, and where, consequently, the successive movements shook down and re-arranged the sands adjoining, so as to obliterate the planes of bedding and substitute vertical planes.



JOINTS IN THE POUGHQUAG QUARTZITE.

In a case of this kind only a force that was comparatively light could have acted, since nearly all the rest of the rock has its stratification perfect, although much jointed. But the same process, if continued, might result in a universal obliteration of the bedding.

It should be noted that after a quartzite had been consolidated this obliteration of the bedding would be an impossibility, however powerful the forces at work. The sand beds must be feebly compacted, or the sands could not be shaken down and re-arranged into a series of vertical or nearly vertical beds. Hence the jointed structure, when connected with absence of planes of bedding, is proof that the forces producing the structure acted *before, or at the time of, the final solidification—certainly not after it.*

Again, the quartzites of different periods are almost identical in structure and mineral characters, so as to afford nothing by which they may safely be distinguished. In the same region all kinds often occur, from the finest and hardest granular quartz to pebbly layers, and to conglomerates made of stones as large as cobble-stones, on one side, and to thin friable layers on the other. The presence or absence of a pearly micaceous or talcoid mineral in the layers is not a distinction of value; for the same stratum may be a pure quartz rock in one place, and even look gneissoid in another.

The conclusion of the whole matter is, that the age of each quartzite outcrop must be determined by an examination of its special stratigraphical relations to the adjoining rocks.

I proceed now to an account of the quartzite of a few Green Mountain localities. The observations at the first two of the following localities, Canaan and Poughquag, were made in conjunction with Mr. James T. Gardner, an excellent stratigraphical observer, and one of the corps of the Clarence King Sur-

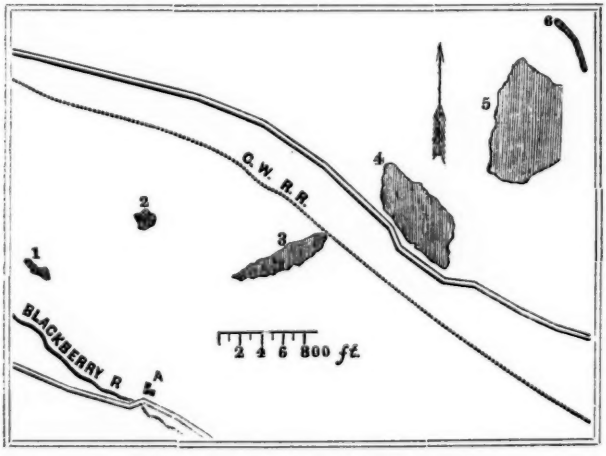
veying Expedition along the 40th parallel, west of the Rocky Mountains.

1. Quartzite of Canaan, Connecticut.

The village of Canaan is situated in Northwestern Connecticut, in the town of North Canaan, the northern town of the State on the east bank of the Housatonic River. Canaan Mountain, an east-by-south and west-by-north ridge, stands along the southern border of the town. The quartzite outcrops occur to the north of this mountain, and within a mile of it, not far from the residence of Dr. Adam, on Blackberry River.

The Green Mountain series of outcrops of quartzite, consisting in Massachusetts of prominent ridges and ridgelets, here has one of its southern terminations, none existing in Connecticut, as far as known, south of Canaan Mountain. This is not, however, the most southern extension of the rock, for other outcrops occur at distant intervals twenty miles farther west, in Dutchess Co., New York, and to the southwestward.

The quartzite of Canaan constitutes low ledges in a region of crystalline limestone and metamorphic schist. There are six of



Map of the Canaan quartzite region.

these ledges over an area exceeding but little a mile from east to west, and half a mile from north to south, as represented in the annexed map,* the scale of which is 1,600 feet to the inch.

Ledge No. 1 is 250 feet long, 80 wide and 20 high above the plain; 2 is 180 feet wide and long, and 24 feet high; 3 is 960

* I am indebted for this map and the measurements of the ledges to Mr. Joseph S. Adam of Canaan. It is reduced from a large map furnished me by Mr. Adam. 1 to 6 are quartzite ledges; A, Dr. Adam's house; C. W. R. R., the Connecticut Western Railroad.

feet long, and 120 feet wide, and 45 high; 4 is 1,080 feet long and 450 wide and 70 feet above the road on the southeast; 5 is 1,400 feet long, and 30 feet above the plain; 6 is 400 feet long.

The surface between the quartzite ledges is covered with limestone; and this limestone is part of the great crystalline limestone of the Housatonic valley, which has in Canaan a breadth, as laid down by Percival, of nearly ten miles. It is a continuation of the Stockbridge limestone of Massachusetts and the Eolian of Vermont; and the same wide band stretches southward, and somewhat westward, through Salisbury, Conn., and Dover and Pawling in Dutchess Co., N. Y.

This limestone is generally admitted to be of Lower Silurian age, and to represent more or less of the time from the Calciferous to the Trenton periods. The fossils from the Eolian limestone of Whiting and Sudbury, Vermont,* identified by Prof. James Hall, included species of the genera *Euomphalus*, *Zaphrentis*, *Stromatopora*, *Chætetes*, and *Stictopora*, with large encrinal stems, and have been regarded as indicating that the rock is not older than the Trenton. Mr. Billings has presented evidence tending to prove that limestones of the Quebec group are included in the formation; and if so, the Chazy is probably present also.†

The dip of the limestone about Canaan varies from nearly vertical to nearly horizontal, the latter prevailing; and there is a like diversity in the strike. Such an irregularity of position is common in this rock elsewhere in the Green Mountain region, whenever it is not tilted throughout at a high angle; and it is evidently owing to the inflexible character of a limestone stratum when subjected to lateral pressure.

The metamorphic schist associated with the limestone is an arenaceous mica schist, which is in part an arenaceous gneiss. It alternates with, or overlies, the limestone, as may be seen in several localities in the vicinity of the quartzite. Rattlesnake mountain, a hill 300 feet high above the plain around it, and situated about a mile and a half north of Dr. Adam's house, has a base of limestone, while made up mainly of the overlying schist, a fine-grained, fragile arenaceous rock, in part gneiss-like. The layers of both rocks are nearly horizontal. The peculiar want of firmness in this superincumbent arenaceous gneiss and mica schist may be owing to the fact that the heat

* Geol. of Vermont, 2 vols. 4to, 1861, i, 418.

† In a paper on a Primordial limestone in Northern Vermont—the Winooski limestone—at page 145 of this volume, Mr. E. Billings suggests that the Stockbridge limestone may not merely include this Primordial limestone, but may be made up of it. His conclusion is based on sections by Professor Emmons, which I shall show, before the close of this paper, are not of a kind to sustain it. Moreover it will appear, on what I think is good evidence, that the Primordial does not enter at all into the proper Stockbridge limestone, although it may constitute other areas not far distant from it.

of metamorphism had to reach it through the thick horizontal limestone formation; for the gneiss where much tilted is a firmer rock. In some places about Canaan it is decomposed to a depth of thirty or forty feet or more, and then resembles a fine-grained soft sandstone.

The quartzite is for the most part the ordinary fine or coarse-grained hard quartz rock. The ledges indicated on the above map are more or less completely surrounded by limestone, so that you cannot get from one ledge to another without crossing a limestone interval, although the distance between is in no case over 400 yards, and in one but little over 100. The quartzite evidently underlies the limestone.

The rock is very strongly and evenly jointed, and nearly vertically so, and the joints are generally the only divisional planes, or are far more distinct than any planes of bedding. The direction of the joints in the several ledges is N. 30° E. to N. 37° E.

There is an exception in ledge No. 5 to this remark with regard to the absence of planes of stratification. This ledge has a bluff front facing the northeast, thirty feet high, in which the bedding is displayed in great perfection. It is made distinct by the alternation of very fine crumbling layers with others of the hard rock. The crumbling layers look as if they might be a calcareous quartzite, but on examination with a lens they proved to be an aggregation of the finest of quartz sand. The strike of the beds was N. 35° W. (compass course), and the dip 50° to the southwestward. The rock was also jointed, and the direction of the joints N. 32° E., conforming to the principal joints in other localities.

In the ledge No. 6, also, the stratification is distinct, but in an opposite direction to that of No. 5, the dip being 25° to the *northeastward*; as if the two, which are but 400 feet distant, were parts of a small fold in the stratification.

The quartzite and the associated limestone are *unconformable*. While in so close association, an interval of but a dozen yards of soil sometimes separating the outcrops, they are no where seen in conformable layers. The schist and limestone outcrop together among the quartzite outcrops, and manifest plainly their intimate relations; but nowhere is this true of the quartzite and limestone. Along the rail-road there is a section of ledge No. 3; and then, but a few rods to the southeast, one of gneiss and limestone together. This isolation of the quartzite is calculated to excite a strong impression that the two are wholly distinct in stratification. As the quartzite is so hard a rock, its outcrops ought to be continued through the limestone areas in long lines if they are conformably interstratified; but, instead, it is in short, low, island-like outcrops.

Again, the jointing is essentially uniform in all the quartzite ledges from 1 to 6, varying little from N. 35° E. In the limestone, on the contrary, there are all kinds of dip and strike, as above stated. Such a hammering as the quartzite formation (sand-beds at the time) must have undergone, before its stratification became so completely obliterated as in most of the ledges, should have left an ineffaceable impression on the limestone, if the limestone were then in existence and overlying it. In ledge No. 1, the jointing is nearly vertical and very decided, while the limestone near by is almost horizontal. This uniformity of structure in the quartzite demonstrates that its origin antedates the deposition of the limestone.

The ledges 5 and 6 (see map, p. 183) are stated to have the opposite dip that indicates a fold. But No. 6 is altogether too narrow to be the counterpart of No. 5, or the other half of the arch. Put the limestone out of the way, and then the difficulty would disappear. If therefore the uplifts of the quartzite, and its uniform system of joints, were produced before the deposition of the limestone and its associated schists, the condition of the rocks would be intelligible.

But the unconformability is directly demonstrated about ledges No. 5 and 6, in which the stratification of the quartzite is distinct. The dip of the quartzite in No. 5 is, as has been stated, to the southwest and that in No. 6 to the northeastward. Between the two, as it were in a basin made in a decapitated fold, limestone lies having a dip nearly that of No. 6. To the northward-and-eastward of No. 6, the strike of the limestone is N. 50° E., with the dip to the northwestward (N. 40° W.) 40°. This dip is persistent around the north and east sides of the quartzite ledge No. 6, and shows a total independence in the positions and relations of the two rocks.

The limestone between the ledges 5 and 6 corresponds more nearly in dip to the quartzite in No. 6, than to the limestone on the north and east; showing that the tilting it underwent was somewhat dependent on the ledges between which it lay; and it thereby indicates that the ledges had a previous existence. The facts favor the idea that the great irregularity in the tiltings of the Canaan limestone and schist, sometimes conforming to the jointings of the quartzite but oftener not, may have been in part due to the resisting ledges of quartzite beneath.

The conclusions to which the facts lead are, therefore:—

(1) That the quartzite is the inferior rock.

(2) That it is everywhere unconformable to the overlying limestone.

(3) That the jointing, uplifting and consolidation of the quartzite took place before the limestone was deposited.

ART. XXIII.—*Brief Contributions to Zoölogy from the Museum of Yale College.* No. XVIII.—*On the Affinities of Paleozoic Tabulate Corals with Existing Species;* by A. E. VERRILL.

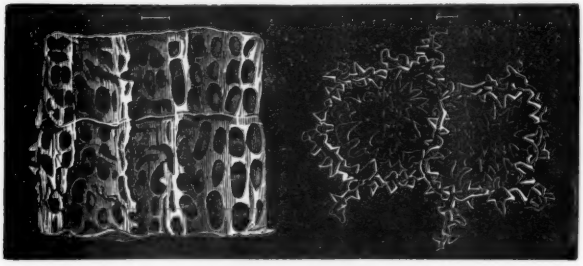
THE works of Milne Edwards and Haime upon corals are so extensive and important, and their classification is so well understood and generally adopted, especially by geologists, that it is of great importance that their errors of classification should be pointed out and fully understood.

A very unfortunate mistake was made when they instituted the exceedingly heterogeneous and artificial group known as "*Madreporaria Tabulata.*" This division was based wholly upon a single character of uncertain value, found in certain corals differing very widely among themselves in all other respects. This character, regarded by them as of such fundamental importance, was merely the existence of complete transverse septa or plates across the coral tubes, or cells, occupied by the lower parts of the bodies of the coral-polyps, thus dividing the lower, unoccupied portion of these coral-cells into a series of closed chambers, each plate in turn marking a former position of the base of the polyp, which occupied the cell, as it grew upward. In most of the other corals, on the contrary, there are either no transverse plates, or else they exist between the radiating lamellæ or septa, thus dividing each of the *radiating chambers* into a series of transverse cavities, which are *usually* not exactly on the same level in the different chambers. At the time when this classification was proposed the polyps of but few of the "tabulate corals" had been examined, and no characters were drawn from the soft parts. The explanation of the transverse septa seems to be, judging from my own dissections and also from analogy with other animals, that they are formed after each discharge of ova; the vacuity thus produced, being useless, is cut off from the visceral cavity above it by the formation of a septum. Therefore, if the eggs be discharged from all the radiating chambers simultaneously, or if from any other cause the polyp abandons all the chambers simultaneously, it is obvious that a complete septum or transverse plate will be formed across the entire tube; but if the eggs be discharged at different times from the ovaries occupying the various radiating chambers, the septa formed below them in the different chambers will not be coincident, or exactly at the same level in all. It would seem, therefore, that the existence, or non-existence, of complete transverse plates is simply a matter of periodicity in the discharge of ova.

We should, naturally, expect to find such variations in periodicity among the species and genera of many diverse groups,

—and this, I think, can easily be shown to be the case. Thus, for example, the genus *Cœlastræa* V., an undoubted Astræan coral, has the septa in all the chambers on the same level, thus forming true tabulæ; the genus *Alveopora* (figure 1, *a*), and others allied to *Porites* and *Madrepora*, have true tabulæ; also the genus *Astræopsammia* V., of the Eupsammidæ; the species of *Pocillipora*, a genus closely allied in its animals, and otherwise, to *Oculina* and *Stylophora*, have very numerous and per-

a Fig. 1.* *b*



fect transverse septa; even among the Alcyonaria, the genus *Tubipora* occasionally has transverse internal septa; and the same is true of *Millepora*, belonging to the class of *Acalephs*.

Notwithstanding the very slight basis upon which the group of "Tabulata" was established, and disregarding the very great and important differences which exist among the corals thus unnaturally brought together, most writers upon corals, whether recent or fossil, during the past twenty years have adopted this classification without hesitation.

And yet this is but another instance forcibly illustrating the general rule that classifications based on single characters are very likely to be artificial and erroneous. It also illustrates the manner in which such an error often leads to others of still greater importance.

In 1857 Professor Agassiz made the very important discovery, that the animals of *Millepora* are not true *polyps*, but genuine *hydroids*, belonging to the class of Acalephs or Medusæ.† But since *Millepora* is a genus belonging to the "Tabulata," he immediately concluded that all the "Tabulata" are, therefore, hydroid Acalephs! And not content with this sufficiently bold

* Figure 1 *a*, a longitudinal section of *Alveopora spongiosa* Dana; 1 *b*, a vertical view of some of the cells; both much enlarged, copied from Dana's atlas of the Zoöphytes of the U. S. Expl. Exp. For the use of this cut I am indebted to Messrs. Dodd & Mead, the publishers of Professor Dana's new work on Corals and Coral Islands.

† Proceedings of the Boston Society of Natural History, vol. vi, p. 373, 1859. See also Pourtales, in Illustrated Catal. of the Mus. of Comp. Zoölogy, No. iv, p. 56, 1871.

generalization, he extended it likewise to the extinct "Rugosa" or Cyathophylloid corals,* at first apparently with some hesitation, but more recently without qualification.†

From this conclusion, if admitted, it followed that in the Paleozoic ages there were few, if any, true polyp-corals, but, on the other hand, the class of Acalephs was abundantly represented by a great variety of coral-making forms, some of them of great size, and capable of building extensive coral-reefs, similar to those made by true polyp-corals in modern times! Thus the geological importance of these two classes of animals would be completely reversed, as well as our ideas of the nature of corals and coral-reefs.

These views have been held and advanced by Professor Agassiz for many years, and have been urged quite recently, notwithstanding the great amount of evidence that has been published to show that the "Tabulata" include corals very diverse in structure and affinities. The proposition of Professor Agassiz to consider all "Tabulate" and "Rugose" corals as Acalephs, has not been very generally adopted, but has been received with more or less hesitation and doubt, by many zoölogists and geologists. In fact, it is not easy to see how Professor Agassiz could reconcile, in his own mind, the structure of many of the Tabulata and Rugosa with his own definitions of the two classes, Polyps and Acalephs. The distinction upon which he and others have chiefly insisted is the existence in the former of radiating fleshy lamellæ, dividing the interior of the body into a number of radiating chambers, in the center of which, in coral-making species, the radiating plates are formed; while in Acalephs no such radiating lamellæ and chambers exist. Therefore it would not be possible for an Acaleph to form a coral having distinct radiating plates or septa, unless we alter our definition of an Acaleph. In that case I do not know what distinction would remain. And yet we find many Tabulate corals, both recent and ancient, with twelve or even twenty-four well-developed radiating septa; and among the Rugosa there are very many genera in which numerous radiating septa are as highly developed as in the ordinary modern corals of undoubted polyp-origin, while in some there are not even traces of *transverse* septa. If we regard the relations of the soft parts to the corals, it will, therefore, be necessary to consider all corals in which *distinct radiating plates* are formed as true polyp-corals, but the absence of such plates is not of itself proof that the coral was not made by a polyp, for many corals now living, and formed by genuine polyps, have no radiating septa (e. g., *Tubipora*, some species of *Pocillipora*).

* Contributions to the Natural History of the United States, vol. iii, pp. 61–3, and vol. iv, pp. 292–6, and p. 338.

† Bulletin of the Museum of Comparative Zoölogy, vol. i, No. 13, p. 384, 1870.

In the present state of science, the only stony corals which are *known* to be formed by hydroids are the several species of *Millepora*. We can reasonably infer that a few other genera having essentially the same structure, or belonging properly to the same family, are also the corals of hydroids. But as to the great majority of the "Tabulata" and "Rugosa," there can no longer be any reasonable doubt that they were made by true polyps, essentially similar to those of the existing corals.*

But among the Tabulate corals, after excluding the *Millepo-ridæ*, great diversities of structure still remain, and no doubt representatives of several families that ought to be widely separated in a natural system, are thus combined together on account of a single unimportant character. Many of these genera are extinct and apparently have no very closely allied representatives among living corals. The affinities of such genera may long remain doubtful. But in other cases there are living corals having very close relations with certain Paleozoic genera, and these we are even now able to classify with as much certainty as we can the ordinary forms of existing corals.

Among the best known of the tabulate corals are the numerous species of *Pocillipora* and allied genera, which evidently constitute a distinct family (*Pocilliporidæ*), largely represented in the tropical waters of the Pacific and Indian oceans. These corals are characterized by rather small, tubular cells, usually with 6, 12 or 24 radiating septa, which even in the same specimen may be obsolete in some of the cells; by *imperforate*, compact walls; and by a more or less abundant, compact cœnenchyma between the lateral cells, which may, however, be absent

* The following quotation from the Bulletin of the Mus. of Comp. Zoölogy, i, No. 13, p. 384, Nov., 1869, will serve to illustrate the views of Professor Agassiz:

"If we now remember that the Acalephian affinities of the *Tabulata* are unquestionable, and that, with them, the *Rugosa* must be removed from the class of Polyps and referred to that of the Acalephs; and if we further take into consideration the fact that *Palæodiscus* belongs to the type of Rugosa, and not to the family of Fungians, it becomes evident that in their order of succession from the Mesozoic era, in which they first make their appearance, the great types of the class of Polyps have succeeded one another in the following order: first Turbinolians, next Fungians, next Astræans, and last Madrepores; in exactly the sequence in which these types stand to one another, as far as their structural gradation is concerned, and in exactly the same order in which, during their growth, these corals pass from one stage to another."

But on the other hand, since we now find that the Acalephian affinities of the Rugosa and most of the Tabulata are wholly imaginary and without the slightest foundation in nature, all this beautiful theory of geological sequence falls to the ground, and we find the *Madrepores* represented even in the Lower Silurian rocks by *Favosites* and other *Alveopora*-like forms, which are certainly neither *low* nor *embryonic* types! And even in Mesozoic times the Astræans appear in force quite as early as the Fungians or the Turbinolians. If there has ever been such a definite geological sequence of the groups of corals as Agassiz imagines, it must have taken place in the ante-Silurian ages, concerning the life of which we know nothing. In the Lower Silurian seas the order was already well developed and highly diversified.

where the cells are crowded, as at the ends of the branches. The writer has shown in several previous papers * that the *Pocilliporidæ* are the corals of *true polyps*. The animals of *Pocillipora* are exsert in expansion, with a regular circle of 12, nearly equal, stout, tapering tentacles, surrounding the circular disk;† and 12 internal, radiating, fleshy lamellæ show through the disk. Thus they closely resemble the polyps of *Stylophora*, *Porites*, and *Madrepora*, which are among the most typical of true polyps. The existence of stellate cells, with 6, and even 12, well-developed, radiating septa in several species of *Pocillipora* (e. g., *P. elongata* Dana, *P. plicata* D., *P. stellata* V.) should be sufficient evidence that such corals have no Acalephian affinities whatever, even without the conclusive evidence derived from a study of the living polyps.

The Silurian genus, *Columnaria*, appears to belong to a different family, and if not actually a member of the Astræidæ, it should at least be referred to a family very near that group. It has 24 to 36 well-developed, imperforate, radiating septa, those of the first cycles wider, and in *C. stellata* (Hall, sp.) reaching the center, while those of the last cycle are quite narrow. The larger septa have the upper edge finely serrate. The walls of the adjacent cells are united together as in *Cœlastræa* and *Goniastræa*; they are solid, and apparently imperforate. The genus closely resembles *Cœlastræa*, but the budding is marginal or interstitial, while in the latter the cells divide across the middle.

Another well-known and important group of tabulate corals was abundantly represented in the Paleozoic seas by the genus *Favosites*, with its numerous species, and by several other allied genera, constituting the sub-family Favositinæ of Edwards and Haime. In these corals the walls are thin and perforated by more or less numerous pores or foramina, which are small in *Favosites*, but large and numerous in *Koninckia*. The cells are usually crowded and polygonal, and there is no cœnenchyma. The radiating septa are sometimes obsolete, but usually 12 or 24, which may be continuous, or represented only by vertical rows of spine-like points, as in *Favosites* and the existing genus, *Alveopora* (figure 1, *b*). The transverse septa are variously developed, being often nearly flat, but with the intervening spaces variable, as in *Favosites;* sometimes partly vesicular and incomplete, as in *Emmonsia;* not unfrequently convex and vesicular, as in *Michelinia;* rarely infundibuliform, as in *Rœmeria*. It is obvious that this group has no relationship

* On the Affinities of the Tabulate Corals, in Proceedings of the American Association for Adv. of Science, 1867, p. 148. Proceedings of the Essex Institute, vol. vi, p. 90, 1869. Transactions of the Connecticut Academy, i, p. 518, 1870. This Journal, vol. i, p. 389, May, 1871.

† Trans. Conn. Academy, i, p. 523, (*Pocillipora lacera* V.). The polyps of *P. damicornis*, as figured by Quoy and Gaimard in the Voyage of the Astrolabe, are quite similar.

with the *Milleporidæ*, and at best only a distant one with the *Pocilliporidæ*, although Edwards and Haime placed it in the same family with the latter.

In the Report on the Zoöphytes of the U. S. Exploring Expedition, 1846, p. 509, Professor Dana instituted the family, Favositidæ, in which he included three sub-families: 1st, Alveoporinæ, including the genus *Alveopora*; 2nd, Favositinæ, embracing *Stylophora*, *Pocillipora*, *Seriatipora*, with *Favosites* and other extinct genera; 3rd, *Helioporinæ*, for *Heliopora*, *Millepora*, *Heliolites*. This family was placed next to the *Poritidæ*. Although more recent discoveries have shown that this arrangement is incorrect in several points, it is, nevertheless, much nearer correct than the classifications of Edwards and Haime, and Agassiz. In thus bringing *Alveopora* and *Favosites* near together, Professor Dana made a very important step in advance, and one that has unfortunately been lost sight of, or overlooked, by recent writers, and most unfortunately by Edwards and Haime, by whom these genera are very widely separated. In describing the genus *Alveopora*, Professor Dana gives, as one of its characters, "transverse septa remote," and on Plate 48, fig. 3, *d*, of his Atlas, from which the accompanying cut has been copied, he figured a vertical section of *Alveopora spongiosa*, in which the transverse septa are well shown (figure 1, *a*). In this species the walls of the cells are exceedingly thin and pierced by numerous large openings, often leaving a mere skeleton of a wall. The transverse septa, although thin, are perfectly developed and imperforate, completely closing the cells at intervals of about ·05 to ·20 of an inch, varying even more than this in some parts of the coral, but not more than do many species of *Favosites*. Moreover the septa in many adjacent cells are situated at the same level, giving the coral the appearance of being divided into successive layers by broad thin transverse plates. This appearance is due merely to the thinness and porosity of the walls and coincidence of the plates. The same arrangement of plates is found in the Silurian genus, *Dania*, which is said, however, to have imperforate walls.

The structure of the walls in the tabulated genus, *Koninckia*, from the Cretaceous, is very similar to that of *Alveopora*. Moreover the latter, like *Alveopora* (figure 1, *b*) has vertical rows of spine-like points, representing the twelve radiating septa. In some, if not all, species of *Favosites* the septa were likewise represented by just such rows of slender points. And the same is true of other extinct genera belonging to the same group. Whether all the species of *Alveopora* have complete transverse septa is uncertain, for they appear to have been generally overlooked by the describers. Edwards and Haime make no allusion whatever to such septa in their descriptions of the genus and its species. In all the species which I have examined, how-

ever, these septa are to be found, but they are usually more remote and less evident than in *A. spongiosa*, while the walls in most of the other species are thicker and perforated by fewer and smaller openings, thus producing firmer corals. In *A. dædalea* Dana* the walls are much thicker and perforated by smaller, rounded orifices, of which there are two or three vertical series on each side of a cell. The cells are very deep and the transverse septa are complete though distant, and coincident in adjacent cells. The radiating septa are represented by twelve vertical rows of stouter spines, which often meet at the center. Mr. W. S. Kent† has described and figured a recent coral, under the name of *Favositipora Deshayesii*, which has well developed transverse septa, and agrees in all other respects, according to Mr. Kent, with *Alveopora*. But as the presence of such septa appears to be characteristic of *Alveopora*, the *Deshaysii* should be regarded as a species of *Alveopora*, in which the transverse septa are, perhaps, unusually numerous. Mr. Kent also mentions a Paleozoic fossil coral, supposed to be from North America, which he refers to the same genus (*F. palæozoica*). This may prove to be an ancient species of the genus *Alveopora*, and in any case cannot be more than generically separated, either from *Alveopora* or *Favosites*, as remarked by Mr. Kent. The genus *Koninckia* of the Cretaceous is, perhaps, not generically distinct from *Alveopora*, approaching *A. dædalea* very closely, and differing from *A. Verrilliana* D. chiefly in having but six vertical rows of septal spines, instead of twelve. The genus *Goniopora* is closely related to *Alveopora*, differing chiefly in having about 24 radiating septa, which are more fully developed, but perforated by large irregular openings; and a distinct columella. The walls are usually rather firm and rough, as if composed of coarse irregular granules, so united together as to leave many openings through the wall. The lateral and younger cells are often very shallow, with a large rough columella, and with six small paliform lobes arising from the inner part of the septa, while in some cases the walls are much thickened and roughly granulous at the surface, in these characters closely resembling *Porites*, to which it is also allied in the internal structure of the coral. In fact, *Goniopora* combines many of the characters of *Alveopora* and *Porites*, and has some additional special characters. The transverse septa are usually quite numerous and thin, usually irregular, but with an evident tendency to coincide in height in all the chambers of the same polyp-cell, though much broken up and forced out of the transverse plane by the presence of the large irregular columella.

* This species, which proves to be distinct from the *dædalea* of Forskal, etc., has been named *A. Verrilliana* by Prof. Dana in his recent work on Corals and Coral Islands.

† Annals and Magazine of Natural History, vol. vi, p. 384, Nov., 1870.

In one species of Goniopora I have occasionally seen cells with a deeply infundibuliform septum completely closing its cavity below, thus recalling the septa of *Rœmeria*.

The three genera, *Goniopora*, *Alveopora*, and *Porites*, agree closely in the characters of their polyps; the first has, however, 24 tentacles, while the others usually have but 12, although there are often a few larger polyps with 24 tentacles, scattered among the smaller ones, in both genera. It seems necessary, therefore, to place these genera and the others that are evidently closely allied to each of them in one family, *Poritidæ*. It will also be understood, from what has already been said, that it is impossible to assign any characters sufficient for separating the *Favositinæ*, even as a family, from the *Poritidæ*. It is very doubtful whether the group can be maintained even as a sub-family, for *Alveopora* and *Goniopora* combine the characters of both groups. The family, PORITIDÆ,* thus extended, might perhaps, be provisionally divided into three sub-families; PORITINÆ, for *Porites* and the closely allied genera; ALVEOPORINÆ, to include *Alveopora*, *Goniopora*, *Litharœa*, and, if considered distinct, *Koninckia* and *Favositipora;* FAVOSITINÆ, to embrace *Favosites*, *Emmonsia*, *Michelina*, and the other closely allied genera. It is probable, however, that even such a slight separation of *Alveopora* and *Favosites* is greater than the differences actually observed will warrant.

Admitting these necessary changes in the classification,† it follows that the *Madreporaria perforata*, or *Madreporacea*, which is generally regarded as the highest division, or sub-order, of the true corals, was abundantly represented even in the Silurian seas. Moreover, the family *Poritidæ*, which now includes many of the most important of reef-building corals, was also, even in Paleozoic ages, a family rich in reef-forming species, for some of the species of *Favosites* grew into hemispherical masses eight or ten feet in diameter. It also seems probable that the genus *Alveopora* has existed through all periods from the Paleozoic to the present time, which would seem the more remarkable, considering the extreme delicacy and fragility of these corals, and also the fact that, so far as known, they are all shallow water and reef species.

* The genus *Montipora*, for which Edwards and Haime constituted their second sub-family of Poritidæ (*Montiporinæ*), belongs properly to the Madreporidæ, as explained elsewhere by the writer (Trans. Conn. Acad., vol. i, p. 501), and where it was also placed by Prof. Dana.

† The opinion that the Favositinæ belong to the Madreporacea was advanced by the writer in 1870 (Trans. Conn. Acad., i, p. 518). Mr. Kent, in the article referred to, published simultaneously with mine, expressed the same opinion and used independently nearly the same arguments. He also uses the argument with reference to the impossibility that a coral with radiating septa could be formed by hydroid polyps, as I had also done both in the paper referred to and in that of 1867. This coincidence of opinion, arrived at through studies pursued in different ways and approached from different directions, could not fail to be gratifying both to the writer and to Mr. Kent.

ART. XXIV.—*Geological and Mineralogical Notes on some of the Mining Districts of Utah Territory, and especially those of the Wahsatch and Oquirrh Ranges of Mountains;* by B. SILLIMAN.

WITHIN the last two or three years, important developments have been made in the mineralogical and metallurgical resources of the eastern ranges of the North American Cordilleras of the Great Basin, and especially in the Wahsatch and Oquirrh Mountains of Utah, in the valley between which flows the Jordan river, pouring the fresh waters of Utah Lake into the Great Salt Lake. It is in these two ranges of mountains that the most important and best known of the "mining districts" of Utah Territory are established.

Commencing on the western slopes of the Wahsatch, near Salt Lake City, we find in order, going southward, the districts known as "New Eldorado," "Big Cottonwood," "Little Cottonwood," and "American Fork"; on the eastern flanks of the same range are the "Uintah" and "Snake Creek" districts; while on the southern extension of the Wahsatch, are the "Spanish Fork," "Mount Nebo" and "Tintic" districts.

On the Oquirrh range, looking to the east, are "the West Mountain" and "Lower Districts:"—"Bingham Cañon" being the most important locality of the first named district. On the western side of the Oquirrh range, looking, in part, over Rush valley, are the "Tooele," the "Stockton," the "Ophir," the "Camp Floyd" and the "Osceola" districts: "East Cañon" in the Ophir district being one of the most important of the new mining regions.

There are other mining districts in the lower extension of the above ranges and also in other ranges of Utah, but we need not dwell on them at present.*

The characteristic metallurgical feature of all the mining districts of the Wahsatch and Oquirrh is the occurrence of ores of lead, rich in silver. The two ranges mentioned fall within the zone of argentiferous galena lodes which extend through New Mexico, Utah and Western Montana.

The writer had occasion, in 1864, while studying the structure of the parallel ranges of Nevada, to note the fact, that these ranges were characterized by the existence in each of parallel zones of metallic veins; sometimes of the precious metals, almost without admixture of base metals, as in the Plutonic rocks of Western

*Two hundred miles farther south, and chiefly in the counties of Beaver and Piuve, upon the so-called "Beaver River range" and "Mineral range," are Washington, Star, Lincoln, Granite and Beaver districts in Beaver county, and the Ohio and Warsaw districts in Piute county: some of these are probably important, but are as yet only imperfectly explored districts, yielding copper, iron, gold, silver, antimony, bismuth, &c.

Nevada, full of evidence of hot springs, solfatara and volcanic action, and yielding such mines as those of the Comstock lode and of Aurora, Bodie, and the White Mountains; or again, those like the Toyabe range, yielding silver with base metals, as antimony, lead, arsenic, copper, zinc, &c., as is also true in a more marked degree of the Humboldt range. So, in the present case, we find in the Wahsatch and Oquirrh ranges ores of silver, either argentiferous galenite, or largely epigene species secondary to galenite, with some ores of copper, antimony, zinc, &c., from which silver is rarely entirely absent. Prof. W. P. Blake, in his catalogue of Californian minerals sent to the Paris Exposition (1867), distinctly points out this parallelism in the metallic contents of the ranges of the American Cordilleras, and the same feature is fully recognized by Mr. King in his chapter on Mining Districts introductory to "Mining Industry," vol. iii of the Geological Exploration of the Fortieth Parallel, p. 5.

The structure of the Wahsatch and Oquirrh ranges is fortunately exposed to view by the cañons, which cut profoundly into them from the valleys. It is in these cañons that most of the mining districts are located, and through them the summits of the ranges are conveniently reached.

The Big Cottonwood and Little Cottonwood cañons, for example, expose profound sections of the Wahsatch range, cutting eastwardly across the structure of these mountains, forming a V-shaped chasm with very precipitous sides and obliquely transverse to the axis of the main range. Thus the average direction of the Little Cottonwood cañon is about N. 62° E., cutting the main range at an angle of about thirty degrees. Entering this cañon, above the mesa over the Jordan valley (Salt Lake Valley), the observer finds himself at once within very precipitous cliffs of gray granite, and surrounded with massive fallen blocks of the same rock of remarkable uniformity of texture and with broad cleavages. The bedded structure of this granite is conspicuous, the beds dipping easterly into the mountain at a high angle, recalling the fan-like structure of the western slopes of the Sierra Nevada as seen in California. This rock extends up the cañon for several miles, the lines of original bedding being distinctly visible. These granites are probably metamorphic of conglomerates, an opinion first suggested to me by Prof. W. P. Blake. Besides the conspicuous patches of darker colored material pasted into the light gray matrix, with the aid of a glass one can detect a certain pebble-like roundness in the quartz of this granite, and an absence of crystalline structure suggestive of a mechanical origin. It is in the lower part of this cañon that the granite has been quarried for building the Mormon Temple at Salt Lake City. These quarrying operations have been confined to splitting the great fallen

masses of granite on the surface, and we may here see fresh faces thus split, measuring, at least, twenty feet vertical by more than this laterally.

At a cabin known as "Garrard's house," some six or eight miles up this cañon, is a fine terminal moraine of the ancient glacier system, forming a complete dam across the cañon, over which the road now winds and through which the mountain torrent finds its way after giving motion to Garrard's mill. The surface of this old moraine I found to be approximately 2140 feet above the Townsend House in Salt Lake City. The Townsend House is about 60 feet above Great Salt Lake, so that the lower end of the ancient glacier system of the Wahsatch at this point was, in round numbers, 2200 feet above the present level of Salt Lake, or 6400 feet above sea level, assuming 4200 feet to be the proper elevation of this inland sea, as commonly stated.

The following heights were determined by one of Green's aneroid barometers, and may be considered as approximate.

	Above Salt Lake.
Townsend House, in Salt Lake City,	60 feet.
Mesa over Salt Lake Valley,	510 "
Emmaville, half-way house,	655 "
Garrard's House, top of old moraine,	2200 "
Central City, six miles above Garrard's,	4460 "
Emma Silver Mine,	5560 "

The loftiest point yet measured in the Wahsatch is the Twin Peaks, which Clarence King has determined. I have not seen his figures, but they are said to make this point over 12,000 feet above tide.

The granite in the Little Cottonwood cañon is followed by heavy bedded quartzites, and these are succeeded by slates, upon which rest conformably thick beds of crystalline white limestones. Obscure forms, probably organic, are occasionally seen on the weathered surfaces of the white limestones, but all I was able to collect of these are so much altered by the metamorphism of the matrix and by exposure as to be mostly unintelligible. A well characterized *Archimedes*, in the possession of Prof. Blake, renders it highly probable that the limestones are, in part at least, Carboniferous, though the geological position of the beds indicates for a large part of the mass a lower horizon. I find by chemical analysis that the white limestones, containing the obscure fossils, are not magnesian. They contain a little silica, with minute scales of white mica, and a little combined alumina and sesquioxide of iron. But the limestones in which the silver ores are found are saccharoidal, and without crystalline structure. They are moreover dolomite in chemical constitution, almost completely free from silica and iron, but containing a little alumina. This latter rock breaks up into small rhombic masses,

and is easily reduced to a fine granular non-crystalline powder, while the non-magnesian beds beneath resemble dolomite in fracture, though quite free from magnesia. They are non-fossiliferous so far as observed by me. Whether they are strictly conformable to the crystalline white limestones is doubtful, and further explorations are needful to decide this point, which is one of considerable interest in view of their metallurgical contents.

The ores of the mines thus far opened in the Wahsatch Mountains are largely composed of species resulting from the oxidation of sulphides, especially galenite and antimonial galena, with some salts of zinc and copper, all containing silver and rarely a little gold. Iron and manganese ochres occur in considerable quantity, mingled with the other products of decomposition. Masses of unchanged sulphides occur, and especially galenite in considerable quantity in some of them; but the process of oxidation has prevailed very extensively, so that the ochraceous character of the ores is the striking feature of most of the mines in this range.

The great chamber of the Emma Mine, which is an ovoidal cavity measuring, so far as explored, about 110 feet vertical by about 80 by 110 feet transverse, was found to be filled almost exclusively with epigene species, the product of oxidation of sulphides, and capable of removal without the aid of gunpowder, for the most part. The study of this mass reveals the interesting fact that it is very largely composed of metallic oxides, with but comparatively small proportions of carbonates and sulphates. Fortunately I am able to present an analysis of an average sample of 82 tons (=183,080 pounds) of first class ore from the Emma Mine, made by James P. Merry of Swansea, April, 1871, which is as follows, viz:

Silica,	40·90	Silver,	0·48
Lead,	34·14	Alumina,	0·35
Sulphur,	2·37	Magnesia,	0.25
Antimony,	2·27	Lime,	0·72
Copper,	0·83	Carbonic acid,	1·50
Zinc,	2·92		90·42
Manganese,	0·15	Oxygen and water by diff.,	9·58
Iron,	3·54		100·00

The quantity of silver obtained from this lot of ore was 156 troy ounces to the gross ton of 2240 pounds.

This analysis sheds important light on the chemical history of this remarkable metallic deposit, and will aid us in the study of the paragenesis of the derived species. It is pretty certain that all the heavy metals have existed originally as sulphides, and we may, therefore, state the analysis thus, allowing 8·52 sulphur to convert the heavy metals to this state.

Silica,	40·90
Metallic sulphides,	52·60
Al ·35, Mg ·25, Ca ·72, Mn^2Mn ·20,	1·52
	95·02
Water, carbonic acid and loss,	4·95

This calculation assumes that the sulphides are as follows, viz:

Galenite,	38·69
Stibnite,	3·30
Bornite,	1·03
Sphalerite (blende),	3·62
Pyrite,	5·42
Argentite,	0·54=52·60

This statement excludes the presence of any other gangue than silica, and considering that the ores exist in limestone, the almost total absence of lime in the composition of the average mass is certainly remarkable. The amount of silica found is noticeable, since quartz is not seen as such in this great ore chamber, nor so far as I could find, in other parts of the mine. The silica can have existed in chemical combination only in the most inconsiderable quantity, since the bases with which it could have combined are present to the extent of less than 1½ per cent, nor do we find in the mine any noticeable quantity of kaolin or lithomarge, resulting from the decomposition of silicates, nor are there any feldspathic minerals. It is most probable that the silica existed in a state of minute subdivision diffused in the sulphides as I have seen it in some of the unchanged silver ores of Lion Hill in the Oquirrh range.

The absence of chlorine and of phosphoric acid in the analysis corresponds well with absence of the species *cerargyrite* and *pyromorphite*, of which no trace could be found by the most careful search among the contents of the mine. The miners speak of the "chlorides," and unscientific observers have repeated the statement that silver chloride is found in the Emma Mine, but the ores indicated to me as such are chiefly antimonic ochres.* The general (perhaps total) absence of the phosphates of lead in the mines of the Wahsatch and Oquirrh Mountains, so far as explored, is a striking peculiarity of the mineralogy of these ranges. On the other hand, the absence of chlorine in the mines of the two Cottonwoods and the American Fork is in striking contrast with the constant occurrence of cerargyrite (horn silver) in the Oquirrh and also in the southern extension of the Wahsatch. I have sought in vain for a trace of this species in the

* There exists generally among the mining population of the central territories of the United States a distinction between *horn silver* and *chloride of silver*, an error arising, as I am persuaded, from supposing the ochreous ores to be chlorides not so perfectly developed as to be sectile.

districts of the Wahsatch just named, and the occurrence of pyromorphite is extremely doubtful.

Molybdic acid, however, exists pretty uniformly disseminated in the mines of the Wahsatch, in the form of *wulfenite*. Although it occurs in minute quantity, it is rarely absent, and may be regarded as a mineralogical characteristic of the districts of the two Cottonwoods and of the American Fork. For this reason a few particulars will be in place here.

Wulfenite is found associated with calamine, cerussite, malachite, azurite and more rarely alone in little cavities in the ochraceous ores. In the "Emma Mine," vugs, or geodes, are occasionally found lined with botryoidal, apple-green calamine, rarely crystallized, often brownish and sometimes colorless, but invariably associated with wulfenite. The calamine encloses and covers the crystals of wulfenite, which form the backing of the calamine and extend into and among crystals of cerussite, which form a lining of considerable thickness. The wulfenite is in thin tabular crystals of a yellow color, resembling the Carinthian variety of this species. The crystals are very brilliant and perfect, but quite minute, rarely two or three millimeters in width, and not over 1mm. in thickness, often less. They are quite abundant in this association, no piece of the calamine which I have seen being without them. They sometimes, but rarely, penetrate through the globules of the calamine so as to show themselves on the upper surface of that species. But the calamine has obviously formed in botryoidal masses around the wulfenite, a crystal of this species being often seen forming the nucleus of the calamine globules.

These facts are of interest in the paragenesis of these epigene species. The order of production has obviously been, first, the cerussite resting on ochraceous iron, manganese, and other metallic oxides; next, the wulfenite crystals were deposited upon and among the crystals of cerussite, and lastly came the calamine, crystalline at first, and as it accumulated becoming fibrous and amorphous, completely enclosing and capping the other species.

Wulfenite occurs also in this mine, as likewise in the "Flagstaff," the "Savage," and "Robert Emmet," without the calamine, but never, as far as observed, without cerussite and other carbonates. In the "Savage," masses of cerussite with various oxides are interpenetrated by the tabular crystals of wulfenite.

Although wulfenite forms a very minute factor of the entire ore mass in these mines, by the law of mineral association it may be considered as the characteristic species of the ores of these districts, occurring in the magnesian limestones. So far as I am informed, or have observed, wulfenite has not been hitherto found in any of the other mining districts of Utah; but by

the same law, it may be reasonably looked for wherever deposits of epigene minerals are explored in the same geological and mineralogical relations in the Wahsatch range of mountains.

The oxidizing and desulphurizing agency which has acted upon the great ore mass of the Emma Mine, whatever it was, has performed its work with remarkable thoroughness. A careful study of its action discloses some other facts of interest in the paragenesis of species. From the appearance of numerous large blocks of ore forming solid boulders in the general mass, a concentric arrangement is easily recognized. On breaking these masses across, the fresh fractures disclose a dark center which consists almost entirely of decomposed sulphides, composed chiefly of cerussite blackened by argentite and metallic silver in a pulverulent form. This dark center, chiefly of cerussite, is often pseudomorph of galenite in its fracture. Next is usually a zone of yellowish and orange yellow antimonial ochre, cervantite, often quite pulverulent, at times only staining the cerussite; then follows a narrower zone of green and blue copper salts, malachite, azurite, cupreous anglesite, with, rarely, wulfenite; then follows cerussite, sometimes stained with antimony ochre, and not unfrequently associated with wulfenite; outside of all are the iron and manganese ochres. This concentric arrangement I have observed in a great number of cases; and the above order of species, while not invariable, is believed to reflect accurately the general arrangement. Well crystallized species, as mineralogical specimens, are rare in this great mass, but the following may be recognized as its chief components:

Galenite, sphalerite, pyrite, jamesonite (?), argentite, stephanite, boulangerite (?), *antimonial galenite*, *cervantite*, mimetite (?) limonite, wad, kaolin, lithomarge, *cerusite*, anglesite, linarite, *wulfenite*, *azurite*, *malachite*, *calamine*. The names of those most abundant or best crystallized are in italics. This list can no doubt be extended as opportunity occurs for the more careful study of the ores, the great mass of which, amounting to many thousands of tons, have gone into commerce without passing under any mineralogical eye.

In a subsequent paper will be presented some remarks upon the Oquirrh range and some of its ores, and notices of minerals from other districts of Utah.

New Haven, January, 1872.

ART. XXV.—*On the genera Cornulites and Tentaculites, and on a new genus Conchicolites;* by HENRY ALLEYNE NICHOLSON, M.D., D.Sc., Professor of Natural History and Botany in University College, Toronto.

I. CORNULITES AND CONCHICOLITES.

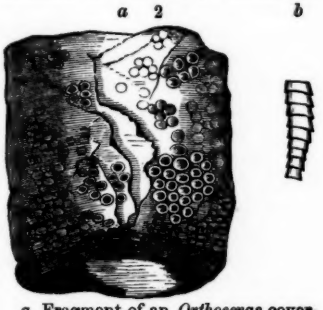
THE genus *Cornulites* was founded by Schlotheim (*Petrefacten*) to include certain Silurian fossils, of somewhat doubtful affinities, but apparently most nearly allied to the tubicolar annelides. The remains included under this head consist of calcareous tubes, with tolerably thick walls, often attaining a considerable size, and tapering towards one extremity, so as to form an extremely elongated cone. The entire tube is somewhat flexuous, and is ringed with irregular annulations; and the smaller end of the tube is not only attached by its sides to some foreign object (McCoy, Salter, &c.), but is usually more or less bent. It is obvious that these characters approximate very closely to those of the recent *Serpulae;* and if this were all, there would be little hesitation in regarding *Cornulites* as a tubicolar annelide secreting a calcareous tube. The tube of *Cornulites*, however, has an extremely complex structure, wholly unlike that of the *Serpulae.* The walls are of very considerable thickness, and are composed of a number of large rounded or oval cellular spaces or cavities, bounded by thin walls; which are especially conspicuous in the transverse ridges or annulations, which surround the tube (fig. 1 *a*). When a cast of the tube is obtained (fig. 1 *b*), we are presented with a solid tapering rod-like body, composed of a longitudinal series of imbricated rings.

a. Upper portion of the tube of *Cornulites serpularius* Schlot., nat. size. From the Wenlock Limestone of Dudley, *b.* Cast of the tube of the same, nat. size.

Each ring is in the form of a truncated cone, having its smaller end directed toward the mouth of the tube, and fitting into the larger aperture of the ring next it in the series. The rings are generally narrower and more crowded together toward the fixed end of the tube, and the entire surface of the cast is quite smooth. The best known species is the *Cornulites serpularius* of Schlotheim, in which the tube attains a length of several inches, and a circumference of about two inches at its

aperture. This species may be recognized, not only by its great size and by the thickness of the investing tube, but by the fact that the external surface of the tube is covered with very numerous and fine longitudinal striæ, communicating to the fossil something of the aspect of a coral.

Recently, several specimens of a new fossil have come under my notice, which I at first referred to *Cornulites*, but which I am now disposed to place, provisionally at any rate, in a new genus, under the name of *Conchicolites*, under the specific title of *C. gregarius*. From their peculiar mode of occurrence, these fossils are of considerable interest, and no doubt can be entertained as to their being truly the remains of tubicolar annelides. *Conchicolites gregarius* occurs in the form of small clustered tubes (fig. 2), generally slightly curved, tapering towards one end, and attached by their smaller extremities to some foreign body. Most of the specimens in my possession occur attached in great numbers to the dead shells of *Orthocerata* (fig. 2), generally along with crusts of *Stenopora fibrosa* Goldf. It is clear, therefore, that *Conchicolites gregarius* very closely resembled in its habits the modern *Serpulae*, and its zoological affinities are altogether beyond doubt.



a. Fragment of an *Orthoceras* covered with the tubes of *Conchicolites gregarius*. Natural size. Only the mouths of the tubes are visible in this specimen. *b*. Cast of the tube of another specimen of the same.

All of my specimens, which show more than the *mouths* of the tubes, are in the state of casts; and I am unable to speak positively as to the characters of the tube itself, except from one or two fragmentary examples. The disappearance, in some cases, of the walls, leaving merely the internal casts, renders it tolerably certain that the tubes were calcareous. It is also to be regretted that the materials at present in my hands do not render it possible to determine the presence or absence of the cellular structure which is so conspicuous in *Cornulites serpularius*. In the specimens growing on *Orthocerata*, as in fig. 2, the tubes themselves are in part preserved; but it is almost impossible to determine their characters. Over all parts of the surface of the shell, where the view is not obscured by the adherent matrix, the tubes are so accurately and closely compacted together that no portion of their lateral surface is exhibited, and nothing can be seen but the *mouths* of the tubes. Where the *Orthoceras* is broken across, one would have expected to get a view of the surfaces of the tubes. Owing, however, to

their growing obliquely and not exactly at right angles to the shell, this is only partially the case, and they appear on this surface in a very fragmentary and obscure condition. A careful examination, however, of this portion of the fossil has convinced me that the exterior of the tube presents the same appearance as the cast, consisting, namely, of a series of imbricated rings. There are, therefore, no traces of the longitudinal striæ which distinguish the outer surface of the tube of *Cornulites serpularius*.

The *casts* of the tubes of *Conchicolites gregarius* (fig. 2 *b*) have exactly the characters of those of *Cornulites serpularius*, but on a greatly reduced scale. Each consists of a succession of short, imbricated, conical rings, the wider ends of which are directed towards the smaller end of the tube, whilst their surface is smooth. From their small size, the casts, on a cursory examination, are not at all unlike specimens of *Tentaculites;* and it seems extremely probable that some of the uncertainty which has prevailed as to the true nature of the latter has arisen from its having been confounded with specimens of the present fossil.

The following are the characters of the genera *Cornulites* and *Conchicolites*, and of the species already alluded to :—

Cornulites Schlot.—Animal solitary, inhabiting a long shelly tube of carbonate of lime. Tube tapering, flexuous, attached by its smaller extremity to some foreign body. Tube annulated externally, with numerous fine longitudinal striæ. Walls of the tube very thick, composed of numerous cellular cavities. Cast of the tube composed of short conical rings fitting into one another in an imbricated manner. Surface of the cast smooth and polished, with one or two longitudinal furrows.

Cornulites serpularius Schlot.—Tube when fully grown attaining a length of three or more inches, with a diameter at its aperture of half an inch or more. Cast of the tube exhibiting about twelve rings to the inch in the fully developed portion. This well known species is distinguished by its large size, its solitary habit, its thick cellular investing tube, and the fine longitudinal striæ of the external surface.

Locality and formation.—Wenlock limestone of Dudley, and Ludlow rocks of Westmoreland, England.

Conchicolites Nich.—Animal social, inhabiting a calcareous (?) tube, attached in clustered masses to some solid body. The tube is conical, slightly curved, attached by its smaller extremity. The wall of the tube is thin, its external surface devoid of longitudinal striæ. The tube thin, composed of short imbricated rings, but apparently destitute of any cellular structure. Cast of the tube composed of short conical rings, its surface completely smooth, and destitute of striæ or furrows.

Conchicolites gregarius Nich.—Tubes closely in contact, attached by their smaller ends to dead shells. Tube varying in length from $\frac{1}{4}$ to $\frac{1}{2}$ an inch, and having a diameter at its mouth of about half a line. Conical rings which compose the tube about four in the space of a line.

From the great similarity presented by casts of the tubes of this species to those of *Cornulites*, I was at first disposed to regard this as a small example of the latter genus. A more careful examination, however, of my specimens has led me to think that they may well be placed in a separate genus. *Conchicolites* is distinguished from *Cornulites* by its social habit, its small size, the thinness of the wall of the investing tube, and the absence, so far as can be made out, of any cellular structure of its tube. In the face of these differences, it is somewhat singular to find that the internal casts of the two should be so absolutely undistinguishable except in point of size. *Conchicolites* presents some resemblances to the genus *Salterella* of Mr. Billings, defined as consisting of "small, slender, elongate-conical tubes, consisting of several hollow cones placed one within another, the last one forming the chamber of habitation of the animal." In *Salterella*, however, the tubes appear to be solitary, and no evidence has been adduced to show that they were attached to foreign bodies, though Mr. Billings regards them as allied to *Serpulites*.

Locality and formation.—*Conchicolites gregarius* occurs not uncommonly attached to the shells of *Orthoceras Brongniarti*, in dark flaggy shales of Caradoc age, Dufton, Westmoreland, England.

II. Tentaculites.

It may not be out of place to add here a few remarks on the genus *Tentaculites* of Schlotheim, though most palæontologists are now agreed as to its zoölogical affinities and systematic position. The genus *Tentaculites* was originally founded by Schlotheim in 1820 (Petrefact, I, p. 377), for certain minute tubular fossils at that time believed to be the terminations of the jointed arms of Crinoids. In more modern times, there have been two leading opinions as to the nature of the fossils in question, some regarding them as tubicolar annelides, whilst others, following Austin, refer them to the *Pteropoda*. Amongst those who held the former view may be mentioned the late Mr. Salter, who retained this opinion up to the time of his death. A good deal of this difference of opinion may doubtless be explained upon the supposition that casts of *Cornulites*, *Conchicolites*, and *Salterella* have been in some cases confounded with the shells of *Tentaculites;* and it is curious to note in thus connection that whilst *Tentaculites* has been referred to the tubicolar annelides,

there have not been wanting observers who would place *Cornulites* amongst the *Pteropoda*.

The shell of *Tentaculites*, as in well known, has the form of a straight conical tube, tapering towards one extremity to a pointed closed apex, and expanding toward the other to a rounded aperture. The walls of the shell are thin, and are surrounded with numerous thickened rings or annulations, sometimes with intermediate striæ, over the whole or part of the length of the tube.

No specimen of *Tentaculites* has ever been found attached to any foreign body; and though this of itself would not be fatal to the view that the genus belongs to the *Tubicola*, the mode of occurrence of the fossil completely negatives this supposition. Thus, Tentaculites are usually found in great numbers together, often over large areas, confusedly scattered over the surfaces of the laminae of deposition. If we had to deal with a tubicolar annelide, it seems certain that specimens would be found imbedded vertically in the rock, with the closed apex downwards, and the aperture directed upwards; or else we should find them attached by their smaller extremities to shells and other foreign objects. On the contrary, the aspect presented by a slab covered with *Tentaculites* is precisely that which would be the result of the fortuitous aggregation on the sea-bottom of a number of small shells, sinking from the upper strata of the ocean. All the evidence, then, at present in our possession goes to show that *Tentaculites* was an oceanic genus, comprising minute pelagic creatures which swarmed at the surface of the Silurian seas, and the shells of which were scattered in myriads on the floor of the ocean when their tenants died. If this be admitted, there can be little hesitation in adopting the view, now almost universally held, that *Tentaculites* is a genus of the *Pteropoda*.

There are, however, two points of resemblance to be noticed by the practical palæontologist between *Tentaculites* on the one hand, and *Cornulites* and *Conchicolites* on the other hand. In the first place, the internal cast of *Cornulites* is not unlike *Tentaculites;* and when we have a small form like *Conchicolites*, the resemblance, if superficial, is very decided. In the second place, Hall asserts that the cast of the shell of *Tentaculites elongatus* is smooth, and "presents the appearance of a series of reversed truncated cones, or short cups, placed one within the other, having all the characters of *Cornulites*." It might, therefore, in some cases, be impossible to decide whether a given specimen were the cast of a *Tentaculites* or the mould of a *Cornulites* or *Conchicolites*, which had been accidentally broken off from its point of attachment.

ART. XXVI.—*On the Meteorites of the Hacienda "La Concepcion" and San Gregorio;* by JUAN URGINDI. (Extract from a letter to Prof. Henry, Secretary of the Smithsonian Institution, to whom we are indebted for the communication.)

THE meteorite that is now at the south corner of the main house of this Hacienda, as seen from the front and in profile resembles the enclosed drawings [drawings not sent].

Nothing is known, with certainty, regarding the fall of this meteorite, nor is it mentioned in the deed of this Hacienda. There is an inscription engraved on the upper part of it which reads thus: "A 1600"; and the antiquated form of these characters has created the general belief that they refer to the year in which the meteorite fell, or rather to that of its discovery, since historical tradition (not to speak of the absurd fable to the effect that Malinche let it fall, while transporting it hidden through the air, on account of a cock having crowed) only tells us that, during the last century, it was discovered buried in the sand, on a piece of bushy land which had been drained, situated eight hundred yards south of this house, whence, unburied, it was taken about a hundred yards off, where it remained a long time; and that in the year 1810, Don Manuel Concha, then Administrator of this Hacienda, removed it and placed it as a sign at the door of a blacksmith's shop, situated about 15 yards from the said corner. There it was when I first knew it, in 1823, and from there my brothers and I managed to roll it to its present place. Lately it has been necessary to straighten it, as it was leaning, in consequence of the sinking of the ground, or of the effects of a stroke of lightning in 1859, which probably damaged also the walls of the corner in question.

With much difficulty, and after spoiling chisels of good steel, several pieces have been cut at different times, resembling the two which I now send you, leaving a brilliant surface where separated. Even a bridle-bit, knives, and some other small objects have been made of it, the first of which articles, it is said, was presented to the late Spanish Commander General of Chihuahua. The blacksmiths assert that the metal is very ductile and malleable. Regarding its chemical composition, it is said to consist almost entirely of iron, with a little nickel. The peculiar appearance of the many little holes seen in its surface show that at some time it was in a state of fusion, since such holes are identical with the cavities left by bursting bubbles.

In regard to its weight and dimensions, I copy what I find in some notes in my possession, which read thus: * * * From the above reckoning, it will be seen that the meteorite measures

39,299 cubic inches. Considering the metal as cast iron, the weight of which is to the weight of distilled water, frozen, as 72,070 is to 1000, and that the cubic centimeter of such water weighs 20·031 grains, we may infer that the meteorite weighs $154\frac{132}{1600}$ "arrobas."*

This is all the information I can give regarding the meteorite of this Hacienda, and I fear it is too scanty, and perhaps too little exact, to satisfy the learned professor for whom it is intended. The pieces that I send will enable him to ascertain the substances of which it is composed; and if some photographer should come in this direction, I will have it photographed, and will take much pleasure in sending you a copy.

I am still less informed in regard to the meteorite of San Gregorio, since I have seen it only twice, in 1856.† It is larger than the one at this place, and seems to consist of the same material, has very much the shape of a sofa, and bears an inscription, which reads thus (translated):

> "Only God with his power
> This iron will destroy,
> For the world will have
> No one able to divide it in pieces."

In my opinion, this meteorite and the one we have here are fragments of another much larger one, that probably burst at a sufficient height from the earth to cast one piece on this Hacienda, another one on that of San Gregorio, 10 leagues to the northwest, and other larger ones on Chupaderos, 20 leagues to the northwest of this place. I have not seen the latter ones, which are said to be the most curious; but I have already taken some steps to have them carefully examined, and I promise to myself the satisfaction of transmitting the result to you.

Art. XXVII.—*On the Mean Motions of Jupiter, Saturn, Uranus, and Neptune;* by Professor Daniel Kirkwood.

The recent note of Professor Peirce,‡ announcing his discovery of some interesting relations between the mean motions of the four outer planets, has recalled my attention to a number of similar coincidences detected by myself several years since, while engaged in a somewhat laborious examination of the

* One arroba is equivalent to 25 lbs.

† For an article on this meteorite by Dr. J. Lawrence Smith, see this Journal, III, i, 335.

‡ This Journal for January, 1872. It will be observed that Professor Peirce's third equation is identical with that discovered by Professor Newcomb in 1857. See Gould's Astr. Journ., vol. v, p. 101.

planetary elements. Of these, the following may be worth putting on record for future discussion:

$$2n^{v} - 3n^{vi} - 11n^{viii} = 0 \quad - - - \quad (1)$$
$$2n^{vi} - 21n^{vii} + 30n^{viii} = 0 \quad - - - \quad (2)$$
$$3n^{v} - 8n^{vi} - 2n^{vii} + 7n^{viii} = 0 \quad - - - \quad (3)$$

With the values of n^{v}, n^{vi}, and n^{vii} adopted in the American Ephemeris, the value of n^{viii} obtained from either of the above equations differs by less than one second from the latest determination.* The second equation was submitted some two years since to Professor Newcomb, of the U. S. Coast Survey. That distinguished astronomer was inclined, however, to regard the coincidence as merely accidental. Be this as it may, I have strong confidence in the accuracy of the third. The re-examination of this last has recently led to the discovery of two others, viz:

$$68n^{vi} - 325n^{vii} + 257n^{viii} = 0 \quad - - - - \quad (4)$$
$$257n^{v} - 844n^{vi} + 587n^{vii} = 0 \quad - - - - \quad (5)$$

both of which, I believe, are accurately true. The fifth, however, is not an independent equation, but is derived from the third and fourth. By means of these equations I have found the remarkable cycle of 11657·24 Julian years, which separates the epochs at which the planets Jupiter, Saturn, Uranus, and Neptune, return to the same relative positions. It is obvious, moreover, from the same equations, that *no three of the four outer planets can ever be in conjunction at the same time.*

Bloomington, Indiana, January, 1872.

ART. XXVIII.—*Brief Contributions to Zoölogy, from the Museum of Yale College.* No. XIX.—*Recent Additions to the Molluscan Fauna of New England and the adjacent waters, with notes on other species;* by A. E. VERRILL.

THE new edition of Gould's Invertebrata of Massachusetts, edited by Mr. W. S. Binney, and published in 1870, was intended to include all the Mollusca, exclusive of the Bryozoa, hitherto observed on the coast of Massachusetts, as well as those from the adjacent waters farther north. Practically, therefore, it included all, or nearly all, the species known from New England and the adjoining British Provinces. A few New England species, previously described or recorded, were, however, omitted or accidentally overlooked. In the present communication it is my intention to enumerate the marine species from New England and closely adjacent waters, not included in Binney's Gould,

* Newcomb's Orbit of Neptune, p. 76.

whether previously known or more recently discovered, so far as known to me from personal observation or from the statements, believed to be reliable, of others;* to describe several new species recently discovered; and to record a few observations on the distribution, structure, and affinities of species previously known.

As more detailed descriptions and fuller synonymy will be given in a work on the Mollusca of the coast of southern New England, now in preparation for the Transactions of the Connecticut Academy of Science, the species will be treated here as briefly as possible. It is believed, however, that the figures will prove sufficient, even with short descriptions, for the easy identification of the new species.

List of species not included in Binney's Gould.

Rossia palpebrosa Owen (?); Hyatt in third Annual Report of the Trustees of the Peabody Academy of Science, p. 79, 1871. Manchester, Mass., in stomach of Hake,—A. Hyatt.

Mangelia cerinum = *Pleurotoma cerinum* Stimp. and Kurtz; Shells of New England, p. 49, pl. 2, fig. 2, 1850. New Bedford, Mass.—Dr. Stimpson; Vineyard Sound, 8 to 10 fath.,—A. E. V. and S. I. Smith.

Scalaria Humphreysii Kiener. Greenport, L. I.,—Sanderson Smith; near Great Egg Harbor, N. J.,—J. E. Todd; Stonington, Ct.,—Linsley ("*S. clathrus*"). The occurrence of this species at Stonington needs confirmation. Linsley's species may have been *S. Grœnlandica.*

Acirsa borealis Morch. = *Scalaria borealis* Beck, 1841, = *S. Eschrichtii* Möll., 1845. Eastport, Maine, 10 to 40 fath., shelly bottom,—A. E. Verrill and S. I. Smith; Greenland,—Möller.

Aclis polita V., sp. nov. Plate vi, figure 5, ×5 diameters. Eastport, Maine, 20 fathoms,—A. E. Verrill.

Turbonilla elegans V., sp. nov. Pl. vi, fig. 4, ×5 diameters. Vineyard Sound, 8 to 10 fath., shelly,—A. E. V., S. I. Smith.

Stylifer Stimpsonii V., sp. nov. On *Euryechinus Dröbachiensis* V., in 32 fathoms, off Long Island,—Capt. Gedney.

Cœcum costatum = *Cœcum Cooperi* Smith (non *C. Cooperi* Carp.), 1863. Pl. vi, fig. 6, ×24 diameters. Vineyard Sound, 6 to 8 fath.,—A. E. Verrill; Long Island,—Sanderson Smith.

Doris bifida V., this Journal, II, vol. l, p. 406, 1871. Eastport, Me., and Savin Rock near New Haven, under stones at low water, laying eggs Oct., 1871,—A. E. Verrill.

Doridella obscura V., this Journal, II, vol. l, p. 408, 1872. Near New Haven at Savin Rock and off South-end, 4–6 fath-

* The following species need confirmation: *Lepton fabagella* Con., Newport; *Yoldia Gouldii* (Dekay); *Tellina versicolor* Dekay (Stratford, Conn.,—Linsley); *Solen viridis* Say (Stonington,—Linsley; N. Jersey,—A. E. V.); *Fusus imbricatus* Dekay; *Littorinella levis* (Dek.) = *Rissoa Stimpsoni* Smith (Stratford, Dekay).

oms,—A. E. V. and E. T. Nelson; Great Egg Harbor, N. J., 2 fathoms, shelly,—A. E. V., S. I. Smith, and J. E. Todd.

Dendronotus robustus V., op. cit., p. 405, fig. 1.
Eastport, Me., and Grand Menan,—A. E. V. and O. Harger.

Cavolina tridentata. Fresh shells dredged in 20 to 25 fathoms off Martha's Vineyard,—A. E. V., Dr. A. S. Packard.

Styliola vitrea V., sp. nov. Plate vi, figure 7, ×3 diameters, off Gay Head, among *Salpæ*,—A. E. V. and Dr. A. S. Packard.

Martesia cuneiformis Adams, =*Pholas cuneiformis* Say.
New Haven, in shells,—G. H. Perkins, perhaps imported.

Angulus modesta V. Plate vi, figure 2, ×5 diam.; 2ª, nat. size.
Vineyard Sound, 6 to 8 fath., and off New Haven,—A. E. V.

Gastranella tumida V., sp. nov. Pl. vi, fig. 3, ×16 diam., 3ª, ×6 diam. Off South-end, near New Haven, 4 to 6 fath.—A. E. V.

Semele equalis, =*Amphidesma equalis* Say.
Stonington, Conn.,—Linsley. This has not been found by recent collectors on this coast, and therefore needs confirmation.

Cryptodon obesus V., sp. nov. Plate vii, figure 2, ×3 diam. Off Martha's Vineyard, 20 to 25 fathoms, mud,—A. E. V., Dr. A. S. Packard.

Cyclocardia Novangliæ = *Actinobolus* (*Cyclocardia*) *Novangliæ* Morse, first Annual Report of the Trustees of the Peabody Academy of Science, p. 76 (figure), 1869.

Astarte lutea Perkins, Proc. Bost. Soc. Nat. Hist., xiii, p. 151, figure, 1869. Near New Haven,—Perkins. The relations of this form are not yet fully ascertained.

Modiola hamatus. Pl. vii, fig. 3, ×2 diam., =*Mytilus hamatus* Say.
New Haven harbor and vicinity, usually attached to oysters,—G. H. Perkins, A. E. Verrill; Gulf of Mexico,—Say.

Cynthia pulchella V., this Journal, III, vol. i, p. 98, 1871.
Eastport,—A. E. V.; Newfoundland Banks,—T. M. Coffin.

Glandula arenicola V., sp. nov.
Murray Bay, Gulf of St. Lawrence,—Dr. J. W. Dawson.

Molgula retortiformis V., this Journal, vol. i, p. 56, fig. 3, 1871.
Bay of Fundy,—A. E. V., S. I. Smith, O. Harger.

Molgula papillosa V. Pl. viii, fig. 4, ×2 diam.; op. cit., p. 57, fig. 4 b, 1871.
Eastport, Me.,—A. E. V.: off Martha's Vineyard,—A. Hyatt.

Molgula littoralis V., op. cit., p. 56, fig. 4ª, 1871.
Eastport, Me.,—A. E. V., S. I. Smith, O. Harger.

Molgula pannosa V., op. cit., p. 55, fig. 2.
Bay of Fundy,—A. E. V.; Murray Bay,—J. W. Dawson.

Molgula pellucida V. =*Molgula producta* Binney, pl. 22, figs. 315, 316, but not the description (non Stimpson).

Eugyra pilularis V. =*Molgula pilularis* V.; l. c., p. 56, fig. 4 c.
Eastport, Me. and Grand Menan,—A. E. V. and S. I. Smith; off Martha's Vineyard, 20 fathoms, mud,—A. E. V.

Perophora viridis V., this Journal, vol. ii, p. 359, 1871.
Wood's Hole and Vineyard Sound, low water to 10 fath.,—A. E. V. and S. I. Smith.

Amouroucium glabrum V., this Journ., vol. i, p. 288, figs. 20–22, 1871. Eastport, Me. and Bay of Fundy,—A. E. V.; Murray Bay,—J. W. Dawson.

Amouroucium pallidum V., op. cit., p. 289.
Eastport, Me. and Bay of Fundy,—A. E. V.; off Martha's Vineyard,—A. Hyatt.

Amouroucium pellucidum V.. op. cit., p. 290.
Point Judith, R. I.,—J. Leidy; Vineyard Sound, etc.,—A. E. V., S. I. Smith, J. E. Todd.

Amouroucium stellatum V., op. cit., p. 291.
Vineyard Sound, Mass., 1 to 10 fathoms,—A. E. V., S. I. Smith, J. E. Todd, H. E. Webster.

Amouroucium constellatum V., this Jour., ii, p. 359, 1871. With the preceding.

Macroclinum crater V.; op. cit., i, p. 292, figs. 23–25, 1871.
Banks of Newfoundland,—T. M. Coffin.

Lissoclinum aureum V., op. cit., p. 444, fig. 26, 1871.
Eastport, Me.,—A. E. Verrill.

Lissoclinum tenerum V., op. cit., p. 445, 1871.
Eastport,—A. E. V.; Newfoundland Banks,—T. M. Coffin.

Leptoclinum albidum V., op. cit., p. 446.
Long I. Sound to Labrador; common in Vineyard Sound, 8–10 fathoms, on shells and stones.

Leptoclinum luteolum V.; op. cit., p. 446.
Vineyard Sound, 8–10 fath.,—A. E. V., S. I. Smith; Bay of Fundy,—A. E. V.

BRYOZOA.

Alcyonidium ramosum V., sp. nov. Pl. viii, fig. 10, ×2 diam.
Long I. Sound, near New Haven, in 1 to 5 fath., common, forming large, much branched, arborescent clumps, a foot or more high,—A. E. V.; Vineyard Sound, Mass., and Great Egg Harbor, N. J.,—A. E. V., S. I. Smith and J. E. Todd.

The following species have been found on the shores of Long Island, but probably not in New England waters:

Donax fossor Say; *Arca ponderosa* Say; *Sigaretus perspectivus* Say; *Diplothyra Smithii* Tryon (Staten I.); *Margarita ornata* Dekay.

Changes in the Nomenclature of Species previously recorded.

It is not intended to revise, at this time, the entire list of New England species; but merely to enumerate a few of the more important and necessary changes. Mr. Dall* has already

* Proceedings of the Bost. Soc. of Nat. Hist., xiii, p. 240, March, 1870.

given a revised list of the species described in Binney's Gould, and has referred the species to the recently proposed genera of the Messrs Adams and others, but not always correctly, even if we admit the validity of the genera recognized by him. Corrections have also been made by others, which are here omitted.

Nassa vibex, var. *fretensis* = *N. vibex* (pars) Say; Binney = *N. fretensis* Perkins.

Astyris lunata = *Columbella lunata* (Say) + *B. Wheatleyi* Dekay (var.) = *C. Gouldiana* Ag.

Lunatia heros = *Natica heros* Say + *N. triseriata* Say (var).

Elysiella catulus (gen. nov.) Plate vii, figs. 5, ×3 diam., and 5ª, = *Placobranchus catulus* Ag.

Onchidoris tenella V., this Jour., vol. l, p. 407, = *Doris tenella* Ag.

Onchidoris grisea V., l. c. = *Doris grisea* Stimp. (MSS.) in Gould.

Onchidoris pallida V., l. c. = *Doris pallida* Ag., in Gould.

Ensatella Americana (Gould, nom. prov.) = *Solen ensis* Gould (non Linn.)

Periploma papyracea. Plate vii, figs. 1, 1ª, ×4 diam., 1ᵇ, ×30 diam.; pl. viii, fig. 1 (anatomy) = *Anatina papyracea* Say.

Turtonia nitida V. (sp. nov.) Plate vii, fig. 4, ×40 diam., and fig. 4ª, = *T. minuta* Gould (not of European authors).

Astarte undata Gould (nom. prov.) = *A. sulcata* Gould, pars (not of European writers).

Astarte lens Stimp. (MSS.) = *A. crebricostata* Gould, fig. 440 (not of Forbes).

Astarte quadrans Gould = *A. quadrans*, + *A. Portlandica* Migh.

Pecten tenuicostatus = *P. tenuicostatus*, + *P. fuscus* Linsl. (young).

Anomia glabra V. = *A. ephippium* (pars) Linn.; Gould, + *A. electrica* Binney (non Linn.), + *A. squamula* Gould (non Linn.), young.

Ostræa Virginiana Gm. = *O. Virginica* Lam. + *O. borealis* Lam. + *O. Canadensis* Lam.

Leptoclinum luteolum V. = *Didemnium roseum* Binney (non Sars).

Botryllus Gouldii V., l. c. = *B. Schlosseri* Gould (non Pallas).

Molgula Manhattensis V., l. c. = *Ascidia Manhattensis* Dekay + *A. amphora* Ag.

Molgula psammophora V. = *A. psammophora* Ag.; Binney.

Eugyra glutinans V. (Möll. sp.) = *Glandula fibrosa* B., pars (species figured), not of Stimpson.

Glandula mollis Stimp. = *G. mollis* B., pars (not the figures).

Pera crystallina V. (Möll. sp., 1845) = *Pera pellucida* Stimp. 1852.

Cynthia partita Stimp. Pl. viii, fig. 7, = *C. partita*, + *? C. rugosa* Ag. (MSS.) + *C. stellifera* V. (var.)

Cynthia carnea V. = *Ascidia carnea* Ag. + *C. gutta* Stimp. + *C. placenta* (pars) Pack. (species figured by Binney).

Cynthia monoceros (Möll. sp.) = *C. condylomata* Pack.
C. echinata (Linn. sp.) = *C. echinata*, + *C. hirsuta* Ag. (young).
Ciona tenella V., l. c. = *Ascidia tenella* Stimp. + *A. ocellata* Ag.
Ascidiopsis complanatus, gen. nov. (Fab. sp.) Plate viii, fig. 8, part of gill, = *Ascidia callosa* Stimp.

[To be continued.]

SCIENTIFIC INTELLIGENCE.

I. Chemistry and Physics.

1. *On an essential improvement in the method of fractional distillation.*—Linnemann has successfully applied to laboratory purposes the principles of a method largely used in the arts, in the construction of the so-called dephlegmators. This principle consists in partially condensing locally the vapor which rises from a boiling liquid, in such a manner that the vapors which subsequently rise shall pass through the condensed liquid, and thus be in a measure washed. The apparatus employed consists simply of a vertical tube attached to the flask, in which the liquid boils, and containing six or eight little caps of platinum wire gauze, separated from each other by small intervals. The tube may also have two or three bulbs blown on it, each bulb being placed first above a wire gauze cap. From the upper part of this tube a lateral tube passes to the condenser, while a thermometer is inserted in the upper end of the tube. The proportions are so selected that more liquid condenses in the bulbs and caps than can flow back through the meshes of the wire-gauze. It is, therefore, necessary occasionally to interrupt the boiling, by removing the lamp. The meshes of the gauze are about 0·75 of a square millimeter, and the caps are easily formed by stamping in a press or mould of hard wood. The tubes and wire caps are easily cleaned by alcohol or ether, without removing the caps. The author gives a number of new determinations of the boiling points of familiar organic liquids in a state of purity. These abundantly illustrate the great value of the method.—*Ann. der Chemie und Pharmacie*, clx, 195. W. G.

2. *On the preparation of Absolute Alcohol.*—Elenmeyer has modified Mendelejeff's method of preparing absolute alcohol by means of quicklime, so as to obtain the same result in much less time. Alcohol of 0·792 is to be boiled with quicklime, in pieces projecting above the surface of the liquid, for from half an hour to an hour, with an inverted condenser, so that the liquid may flow back into the flask. The condenser is then to be reversed, and the alcohol distilled over. If the alcohol contains more than 5 per cent of water, the process must be repeated two or more times. If the alcohol contains much water, the lime should not, on the first boiling, be allowed to project above the liquid. It is best to fill the vessel containing the alcohol only half full of pieces of lime, as

otherwise it may be broken by the rapid formation of the hydrate. In any case, the process enables the chemist to prepare, in a few hours, several liters of absolute alcohol.—*Ann. der Chemie und Pharmacie*, clx, 249. W. G.

3. *On the action of Light upon Chlorine and Bromine.*—BUDDE has communicated the results of a series of experiments which appear to show conclusively that chlorine and bromine expand when exposed to the so-called chemical rays of light. The apparatus employed by the author consisted of a differential thermometer, like that of Leslie, the bulbs being filled with chlorine, and exposed to the different rays of the spectrum. The bulbs were 5–6 centimeters in diameter, the connecting tube 1^{mm} in diameter and 30 centimeters in length. The liquid used was sulphuric acid, previously saturated with chlorine. The bulbs were so placed that each could be illuminated, by a definite portion of the spectrum. Their distance from the prism varied from 1 to 2 meters. The index was illuminated with gas and observed by a telescope with cross lines. When the temperature had become stationary, the zero point was noted, and the illumination then varied. Calling the two bulbs A and B, it was found that whenever A was placed in the red of the spectrum and B was dark, a change of from $\frac{1}{2}$ to 1 millimeter, indicating a trifling expansion of the gas in A, was observed. When A was placed in the blue, violet, or ultra-violet, and B was dark, the expansion amounted, as a maximum, to 7^{mm}. Corresponding results were obtained by reversing the relative positions of the two bulbs in the spectrum. Budde considers it proved that substances exist which increase in volume when exposed to the chemical rays, as all bodies do when exposed to heat. He suggests the following possible explanation of the phenomenon:

(1.) Light may decompose the chlorine molecules into atoms.

(2.) The refrangible rays of light may produce in chlorine some other unknown species of work, which may, in its turn, be converted into heat, and thus cause expansion.

(3.) We may assume that there are bodies which are warmed by violet more than by red light. The usual division of the spectrum into a heating and a non-heating portion, depends on the relation of the incident rays to the lamp-black surface of the thermopile, and if this were not warmed by the red rays, we might consider them as exerting no heating effect.

The author considers the first of these views as most probable, and promises a further investigation of the subject.—*Pogg. Ann.*, cxlix, p. 213. W. G.

4. *On the Ammonia-platinum Bases.*—CLEVE has communicated, to the Chemical Society of Paris, a resumé of his elaborate and most successful study of the ammonia-platinum bases. Although some of his results have already been given in this Journal, an abstract of the whole subject, from a single point of view, will, doubtless, prove of interest. The author adopts Blomstrand's theory of the constitution of these bodies, and gives the following as the formulas of the 12 known bases:

1. Platosamine (Reiset's second base), $\overset{II}{Pt}\left\{\begin{matrix}NH_3\\NH_3\end{matrix}\right.$
2. Platoso-semi-diamine, $\overset{II}{Pt}\left\{NH_3 . NH_3\right.$
3. Platoso-mono-diamine, $\overset{II}{Pt}\left\{\begin{matrix}NH_3 . NH_3\\NH_3\end{matrix}\right.$
4. Platoso-diamine (Reiset's first base), $\overset{II}{Pt}\left\{\begin{matrix}NH_3 . NH_3\\NH_3 . NH_3\end{matrix}\right.$
5. Platinamine (Gerhardt's base), $\overset{IV}{Pt}\left\{\begin{matrix}NH_3\\NH_3\end{matrix}\right.$
6. Platino-semi-diamine, $\overset{IV}{Pt}\left\{NH_3 . NH_3\right.$
7. Platino-mono-diamine, $\overset{IV}{Pt}\left\{\begin{matrix}NH_3 . NH_3\\NH_3\end{matrix}\right.$
8. Platino-diamine (base of Gros & Räwsky), $\overset{IV}{Pt}\left\{\begin{matrix}NH_3 . NH_3\\NH_3 . NH_3\end{matrix}\right.$
9. Diplatinamine, $\overset{VI}{Pt_2}\left\{\begin{matrix}NH_3\\NH_3\\NH_3\\NH_3\end{matrix}\right.$
10. Diplatoso-semi-diamine, $\overset{II}{Pt_2}\left\{\begin{matrix}NH_3 . NH_3\\NH_3 . NH_3\end{matrix}\right.$
11. Diplatino-semi-diamine, $\overset{VI}{Pt_2}\left\{\begin{matrix}NH_3 . NH_3\\NH_3 . NH_3\end{matrix}\right.$
12. Diplatino-diamine, $\overset{VI}{Pt_2}\left\{\begin{matrix}NH_3 . NH_3\\NH_3 . NH_3\\NH_3 . NH_3\\NH_3 . NH_3\end{matrix}\right.$

In the present paper the author describes the salts of several very complex radicals, understanding simply by this term a complex of atoms which may be transferred without change from one compound to another.

If we denote by R the molecule, $Pt\left\{\begin{matrix}\Theta\\2NH_3 . \Theta\\2NH_3\\\Theta H\end{matrix}\right\}S\Theta_2$,

we have the following compounds as crystalline salts:

$RCl+2H_2\Theta$, $PtCl_4 . 2RCl+2H_2\Theta$, $RB_2+2H_2\Theta$, $RN\Theta_3$, $R_2S\Theta_4+3H_2\Theta$, $R_2C_2\Theta_4+2H_2\Theta$, $R_2CrO_4+xH_2\Theta$, $R_2C_2\Theta_7$.

If we denote by R the molecule, $\overset{IV}{Pt}\left\{\begin{matrix}\Theta H\\2NH_3\\2NH_3\\C\Theta_2 . CH_3\end{matrix}\right.$,

we have the following crystalline salts:

$2RCl_2+H_2\Theta$, $\begin{matrix}R\left\{\begin{matrix}Cl\\Cl\\Cl\\Cl\end{matrix}\right.\end{matrix}\begin{matrix}\}Cl\\\}Cl\end{matrix}PtCl_2+2H_2\Theta$, $R . 2N\Theta_3$, $2(R.S\Theta_4)+3H_2\Theta$, $RCr_2\Theta_7+H_2\Theta$.

The iodide and iodo-nitrate of platino-diamine give with ammonia two compounds having respectively the formulas:

$$(1.)\ \overset{vi}{Pt}_2\begin{cases} I \\ 2NH_3 . I \\ NH_3 . NH_2 \\ NH_3 . NH_2 \\ 2NH_3 . I \\ I \end{cases} + H_2\Theta \quad \text{and} \quad (2.)\ \overset{vi}{Pt}_2\begin{cases} I \\ 2NH_3 . N\Theta_3 \\ NH_3 . NH_2 \\ NH_3 . NH_2 \\ 2NH_3 . N\Theta_3 \\ I \end{cases}.$$

The first of these bodies gives with nitric acid a nitrous-iodo-nitrate of platino-diamine, $\overset{iv}{Pt}\begin{cases} N\Theta_2 \\ 2NH_3 . N\Theta_3 \\ 2NH_3 . N\Theta_3 \\ I \end{cases}$; the second gives with nitric acid the iodo-nitrate of diplatino-diamine,

$$\overset{vi}{Pt}_2\begin{cases} I \\ 2NH_3 . N\Theta_3 \\ 2NH_3 . N\Theta_3 \\ 2NH_3 . N\Theta_3 \\ 2NH_3 . N\Theta_3 \\ I \end{cases}.$$

This salt is decomposed by chlorhydric acid, and gives small octrahedrons having the formula, $Pt\begin{cases} I \\ 2NH_3 . Cl \\ 2NH_3 . Cl \\ Cl \end{cases}$. By double decomposition it gives the salts:

$\overset{vi}{Pt}_2 . 8NH_3 . I_6$, $\overset{vi}{Pt}_2 . 8NH_3 . (S\Theta_4)_2I_2$, $Pt_2 . 8NH_3 . (P\Theta_4H)_2I_2$,
$Pt_2 . 8NH_3 . (C_2\Theta_4)_2I_2$, $Pt_2 . 8NH_3 . (N\Theta_3)_4(H\Theta)_2$,
$Pt_2 . 8NH_3 . 6N\Theta_3 + 4H_2\Theta$, $Pt_2 . 8NH_3 . Cl_4(\Theta H)_2 + H_2\Theta$,
$Pt_2 . 8NH_3 . (S\Theta_4)_2(\Theta H)_2 + 2H_2\Theta$, $Pt_2 . 8NH_3 . (P\Theta_4)_2 + 2H_2\Theta$,
$Pt_2 . 8NH_3 . (Cr_2\Theta_7)_2(\Theta H)_2$ and $Pt_2 . 8NH_3 . (C_2\Theta_4)_2 + 2H_2\Theta$.

By the action of bromine on the basic nitrate

$$Pt_2 . 8NH_3 . (N\Theta_3)_4(H\Theta)_2,$$

Cleve obtained the bromo-nitrate $Pt_2 . 8NH_3 . (N\Theta_3)_4Br_2$, from which by double decomposition the following salts were formed:

$Pt_2 . 8NH_3 . Cl_4 . Br_2$, $Pt_2 . 8NH_3 . (S\Theta_4)_2Br_2 + 2H_2\Theta$,
$Pt_2 . 8NH_3 . Br_2 . (C_2H\Theta_4)_2 . C_2\Theta_4$.
—*Bulletin Mensuel de la Société Chimique de Paris, April, May and June*, 1871, p. 181. W. G.

5. *Capillary attraction.*—Mr. Valson has shown that in capillary attraction the product of the density of a saline solution and the height to which it rises is a constant. Thus a solution of nitrate of lithium, the density of which is 1·036, rises in a capillary tube to 59 millimeters; and the product of these numbers is 61·9. A solution of nitrate of silver, of a density 1·133, rises to 54·2 millimeters; and the product is 61·7, differing but slightly from that with nitrate of lithia.—*Acad. Sci. Paris, Jan.* 8; *L'Institut, Jan.* 10.

II. Geology and Natural History.

1. *Geological Survey of Ohio. Report of Progress in* 1870.—The notice of this Report, commenced on page 143, is here continued.

Prof. Edward Orton reports on the geology of Highland Co. The rocks of this county range from the upper beds of the Cincinnati group, through the Clinton, Niagara and Helderberg limestones, the Huron Shales (Black Slate) to the Waverley Sandstone. The maximum thickness in the county is 875 feet, 100 of this being the Cincinnati group (Lower Silurian), 50 the Clinton, 275 the Niagara, 100 the Helderberg, 250 the Huron shale (Devonian), 100 the Waverley (Lower Carboniferous); but this maximum thickness does not occur at any one place. The highest elevations of the county are Stults's Mountain and Fisher's Knob, the former 1,325 feet above the sea, and the latter about 20 less; Long Lick Mountain, east of Carmel, is 1,254 feet above the sea.

Prof. Orton reports the occurrence of the red lenticular iron ore of the Clinton group (an important ore in Central New York), near Sinking Spring, just south of the Highland county line. The following paragraphs relate to an important point connected with the Clinton beds and the earlier condition of Southern Ohio:—

"A very interesting fact in the Clinton limestone of Highland county remains to be mentioned. A bed of limestone conglomerate, several feet in thickness, occurs near the base of the series in the southern part of the county. But a single exposure of the conglomerate has yet been noted. This is found one mile due west of Belfast, on the Belfast and Fairfax road, on the land of Charles Dalyrymple. The pebbles that compose the conglomerate appear to have been derived from the blue limestone or Cincinnati rocks. The conglomerate is also fossiliferous, well-worn forms of ancient life being incorporated with it. The fossils can be referred either to the Cincinnati or Clinton group, as they consist of forms that are common to both formations, viz: cyathophylloid corals of the genus Streptelasma and the remarkable fossil—Orthis lynx—a bivalve shell of immense vertical range, as is shown by its occurrence in the Trenton, Hudson (Cincinnati), Clinton and Niagara limestones of the Lower and Upper Silurian ages, successively. It seems more probable, however, that the fossils in question were derived from Clinton seas rather than from the waste of rocks of a previous age.

"The occurrence of this conglomerate attests the existence of land near by—the shores of which were wasted by the sea, and the water-worn and rounded fragments of which were re-deposited on the floor of the sea. Since the first systematic study of the geology of the Mississippi valley, proofs have been accumulating that a Silurian island stretched northeastward from Nashville, toward and beyond Cincinnati. Highland county furnishes its full quota of facts as to the existence and as to certain of the boun-

daries of this ancient land. Other facts will be adduced that bear upon this point in the description of the remaining formations of the county. The date of the uplift of this island is approximately determined by the fact already quoted—as land at the westward is found in existence early in the history of Clinton time. This folding of the crust, then, that transformed a portion of the ancient sea-bottom into dry land, probably occurred about the close of Lower Silurian time, and it seems also safe to say that it not only marks the date, but furnishes the producing cause of the great change in the formation that then took place.

Next follows a full Agricultural Report by John H. Kleppart, embracing observations on the meteorology of the State, and various matters of general interest.

The Chemical Report by T. G. Wormley contains numerous analyses of the coals, iron-ores, fire-clays, limestones and soils of the State, a discussion of the yield of the coal in gas and coke, and of the character of these products; and all his results show the skillful chemist. We cite a few facts.

The amount of *moisture* in the coals of the State varies from 1·10 to 9·10 p. c., those of the southern part of the State containing the most. The coal loses less in weight at a temperature of 240° F. than at 212° F.; if, after heating at 212° F., it be exposed to a heat of 240° F., "it will generally increase in weight, owing to the absorption of oxygen."

Two coals which at 212° F. lost 7·70 and 7·40 p. c. in weight, regained, on cooling, in 5 hours, 4·20 and 4·50 parts; and in 20 h., 4·70 and 5·10 parts.

The average of *ash* in 88 bituminous coals examined, south of the line of the Central Ohio Railroad, was 4·718 p. c., and in 64 coals north of said line, 5·120 p. c. The mean average of ash in 11 cannel coals was 12·827 p. c.

With regard to the *sulphur in coal*, Prof. Wormley says:—

"In the report for last year, Prof. Andrews drew attention to the fact that our analyses had shown, contrary to the usually received opinion, that the *sulphur* present in coals was not always, at least, wholly in combination with iron. A number of additional examinations have been made, all of which confirm this view.

"A sample of Straitsville coal contained 0·57 per cent of sulphur, of which 0·26 were left in the coke. Of iron, the coal contained only 0·075 per cent. This amount of iron would require, to form bisulphuret of the metal, only 0·086 parts of sulphur, thus showing that about 0·48 of the 0·57 parts of the sulphur present in the coal were in some other combination than with iron.

"Again, another sample of coal containing 0·98 per cent of sulphur, of which 0·66 parts remained in the coke, contained only 0·086 per cent of iron, which would require only about 0·097 parts of sulphur, leaving about 0·90 parts of sulphur uncombined with iron.

"The following table exhibits the amount of sulphur and of iron found in several different coals, and the proportion of the sulphur that could have been combined with iron:—

Sulphur in coal,	0·57	1·18	0·98	2·00	0·91	0·86	0·57	0·74	4·04
Iron in coal,	0·075	·742	·086	·425	·122	·052	·102	·102	2·05
Sulphur required by iron,	0·086	·848	·097	·486	·139	·06	·116	·116	2·343

The analyses of the limestones of the State show that the most of them are *magnesian;* the Cincinnati or Blue limestone contains ordinarily little magnesia; yet an analysis of the Blue limestone of Miami valley gives 5·05 p. c. of carbonate of magnesia. The Clinton group limestone contains in general about 12 p. c. of the magnesian carbonate, the Niagara 35 to 49 p. c.; the Corniferous 28 to 40 p. c.; the Water-line mostly 38 to 44 p. c. The facts, with others through the country, show that, if the making of dolomites required the presence of mineral springs, such springs must have been in almost universal outflow throughout most limestone-making regions.

The remainder of the volume is occupied by the reports on local geology by M. C. Read and G. K. Gilbert; a sketch of the present state of the manufacture of iron in Great Britain, by W. B. Potter, E. M.; and a sketch of the present state of the Steel Industry, by Henry Newton, E. M. Mr. Read speaks of the abundance of glacial markings in Geauga Co., and states that their direction varies much, but has a close relation to the topography.

Mr. Gilbert, speaking of the Lake beaches in Fulton Co., states that the highest beach, on which the village of Fayette is situated, is 220 feet above the present level of Lake Erie; a second is 25 feet lower; and the third, which is an excellent site for a road, and is so used through half of the county, has a height of 165 feet above the Lake.

2. *On new Tree Ferns and other Fossils from the Devonian;* by Dr. J. W. Dawson. (Quarterly Journal of the Geological Society for August, 1871.)—Of the numerous ferns now known in the Middle and Upper Devonian of North America, a great number are small and delicate species, which were probably herbaceous; but there are other species which may have been tree ferns. Little definite information, however, has, until recently, been obtained with regard to their habit of growth.

The only species known to me in the Devonian of Europe is the *Caulopteris Peachii* of Salter, figured in the Quarterly Journal of the Geological Society for 1858. The original specimen of this I had an opportunity of seeing in London, through the kindness of Mr. Etheridge, and have no doubt that it is the stem of a small arborescent fern, allied to the genus *Caulopteris* of the Coal-formation.

In my paper on the Devonian of Eastern America (Quart. Journ. Geol. Society, 1862) I mentioned a plant found by Mr. Richardson at Perry, as possibly a species of *Megaphyton*, using that term to denote those stems of tree ferns which have the leaf-scars in two vertical series; but the specimen was obscure, and I have not yet obtained any other.

More recently, in 1869, Prof. Hall placed in my hands an interesting collection from Gilboa, New York, and Madison county, New York, including two trunks surrounded by aerial roots, which I have described as *Psaronius textilis* and *P. Erianus* in my 'Revision of the Devonian Flora,' now in the hands of the Royal Society.* In the same collection were two very large petioles, *Rhachiopteris gigantea* and *R. palmata*, which I have suggested may have belonged to tree ferns.

My determination of the species of *Psaronius*, above mentioned, has recently been completely confirmed by the discovery on the part of Mr. Lockwood, of Gilboa, of the upper part of one of these stems, with its leaf-scars preserved and petioles attached, and also by some remarkable specimens obtained by Prof. Newberry, of New York, from the Corniferous limestone of Ohio, which indicate the existence there of three species of tree ferns, one of them with aerial roots similar to those of the Gilboa specimens. The whole of these specimens Dr. Newberry has kindly allowed me to examine, and has permitted me to describe the Gilboa specimen, as connected with those which I formerly studied in Prof. Hall's collections. The specimens from Ohio he has himself named, but allows me to notice them here by way of comparison with the others. I shall add some notes on specimens found with the Gilboa ferns, and on a remarkable plant from the Devonian of Caithness, kindly placed in my hands by Dr. Wyville Thomson.

It may be further observed that the Gilboa specimens are from a bed containing erect stumps of tree ferns, in the Chemung group of the Upper Devonian, while those from Ohio are from a marine limestone, belonging to the lower part of the Middle Devonian.

The paper continues with descriptions of *Caulopteris Lockwoodi* Dawson, *C. antiqua* Newberry, *C. peregrina* Newberry, and some other species, and is illustrated by a plate.

3. *Supposed legs of Trilobites.*—Mr. Henry Woodward, of the British Museum, in a reply to the paper by the writer in volume i, p. 320, of the present series of this Journal, supports the view that the supposed legs are real legs. He says that the remark that the calcified arches were plainly a calcified portion of the membrane or skin of the under surface is "an error, arising from the supposition that the matrix represented a part of the organism." But Prof. Verrill, Mr. Smith and myself are confident that there is on the specimen an impression of the skin of the under surface, and that this surface extended and connected with the arches, so that all belonged distinctly together.

Moreover the arches are exceedingly slender, far too much so for the free legs of so large an animal; *the diameter of the joints is hardly more than a sixteenth of an inch outside measure; and hence there is no room inside for the required muscles.* In fact, legs with such proportions do not belong to the class of Crustaceans. Moreover the shell (if it is the shell of a leg instead of a calcified arch) is relatively thick, and this makes the matter worse.

* Abstract in Proceedings of Royal Society, May, 1870.

We still hold that the regular spacing of these arches along the under surface renders it very improbable that they were legs. Had they been closely crowded together, this argument would be of less weight; but while so very slender, they are a fourth of an inch apart. Mr. Woodward's comparison between the usual form of the arches in a Macrouran and that in the tribolite does not appear to us to prove anything. We therefore still believe that the specimen does not give us any knowledge of the actual legs of the trilobite. Mr. Woodward's paper is contained in vol. vii No. 7, of the Geological Magazine. J. D. D.

4. *Report on the Geological Structure and Mineral Resources of Prince Edward Island;* by J. W. DAWSON, LL.D., assisted by B. J. HARRINGTON, PH.D. 52 pp. 8vo, with 3 lithographic plates. (Printed by authority of the Government of Prince Edward Island). —We gather from this excellent report the following facts.

The rocks are (1) newer Carboniferous, red-brown and gray sandstones like those of Nova Scotia, and New Brunswick, occurring principally between Orwell and Pownal Bays in Governor's Island, and in Hillsborough Bay, and near the line of coast facing northwest; (2) Triassic bright red sandstones, much like those of Nova Scotia and the Connecticut Valley; (3) drift deposits, and (4) those of later date. The unconformability of the red sandstones of the Trias over those of the Carboniferous is "not very perceptible," and in aspect they are often very similar.

In the Carboniferous there are numerous trunks of coniferous trees, the largest observed a foot in diameter, which are of the species *Dadoxylon materiarum* Dawson, a Nova Scotia species. They have afforded also in some localities *Calamites Suckovii* Brngt., *C. cistii* Brngt., *C. gigas* Brngt., *C. arenaceus* Jäger, *Cordaites simplex* Daws., *Walchia* (*Araucarites*) *gracilis* Daws., *Walchia* (*A.*) *robusta* Daws., *Pecopteris arborescens* Schloth., *P. rigida* Daws., *P.* near *oreopteroides* Brngt., *Neuropteris rarinervis* Bunbury, *Alethopteris nervosa* Brngt.

The Triassic beds have a thickness not exceeding 500 feet, and the lower 270 feet are regarded as constituting a lower division. The dip is very small, and the beds are often characterized by oblique lamination. The fossils are almost the only means of distinguishing the beds from those of the Carboniferous. At New London, in the lower part of the Upper Trias, or upper part of the Lower, was found the jaw of the *Bathygnathus borealis* described by Leidy. Besides this species, the Trias of the island has afforded remains of *Dadoxylon* (*Araucaroxylon*) *Edvardianum* Daws., *Cycadoidea* (*Mantellia*) *Abequidensis* Daws., a *Knorria? Sternbergia*, *Fucoids.*

5. *Peculiar Phenomena observed in Quarrying;* by W. H. NILES, Prof. Phys. Geol. and Geogr. in the Massachusetts Institute of Technology.—The phenomena here described are fractures, sudden movements, and expansions of beds of stone connected with quarrying, and due apparently to the state of tension to which the bed was subjected when in its original state in the

quarry. The author mentions a spontaneous fracture in a bed of gneiss three feet and nine inches thick, which was sixty-one feet long, and mainly in the direction of the strike, but in the southern half with some abrupt transverse (to the east) turns. The transverse fractures were opened wider than the north and south, —in two and a half months, the former five-eighths of an inch, the latter nowhere over one-fourth—showing that there was less resistance to motion in the direction of the strike. He mentions cases of anticlinals formed by movements in beds. In one instance a bed of gneiss twenty inches thick had been elevated an inch and a half, the northern slope of the anticlinal measuring twenty-three feet. The fold trended east and west, and at one end there was a crack three-sixteenths of an inch wide. In another instance in a bed three inches thick, the amount of elevation at the center was one inch, and there was a fracture along the whole length of the crest, trending east and west. Prof. Niles observed a bend form in a bed two and three-quarter inches thick; in a few hours the portion of the bed forming the crest was elevated three inches and a quarter, and the crest—five and a half feet long—had a fracture along it. He learned that sudden sounds or explosions sometimes attend the movements and fracturings; and the sounds occur in all seasons, though more frequent in summer. Sometimes they are louder than the report from a blast, and at one time led to the supposition that the powder magazine had exploded.

The following is an example of the expansion of the rock during quarrying. A mass split off along one side, by wedges in a series of drill holes, for a length of 354 feet (requiring 1,200 wedges) in the direction of the strike, or nearly north and south, had a width of eleven feet and a thickness of three. By one end it was still attached. Soon after the fracture was made, it was observed that the halves of the drill holes were not opposite, and at the free extremity the amount of dislocation amounted to an inch and a half; or in other words, the stone was an inch and a half longer after the fracture than before. The subsequent exposure of the stone to the varying temperature and conditions of the weather for two months produced no change. As the free extremity was higher than the other, the phenomenon was not produced by gravity. Three other instances are mentioned of similar effects, on a smaller scale.

6. *Fossils from the so-called Huronian of Newfoundland.*— Mr. E. Billings read a paper on this subject before the Natural History Society of Montreal, on the 29th of January. The Huronian of Newfoundland includes, according to the geologist in charge of its survey, A. Murray, sandstones, slates and conglomerates, lying unconformably beneath the Primordial beds, which latter are largely developed and abound in fossils. The fossils in the Huronian are of two species. One is broad ovate (6 lines long by 5 broad), with a ring-like border, inside of this a groove, and the interior raised roof-like, with an angular ridge or crest along the middle. In allusion to the shield-like form, a little like

an oblong Patella, it is named by Billings *Aspidella Terranovica.* Two specimens occur on one slab of stone. The relations of the fossil are not determined. The other fossil is regarded by Billings as identical with the *Arenicolites spiralis*, found in Sweden below or at the base of the Primordial.

These fossils were first found by Mr. Murray in 1866, and others were subsequently obtained by Capt. Kerr, Mr. Robinson and Mr. Howley.

7. *Bathmodon, a new genus of fossil Mammals;* by E. D. COPE. (Read before the Am. Phil. Soc., Feb. 16, 1872.)—This genus has a remote affinity to Palæosyops and Titanotherium. The characters of the molar teeth indicate that it belongs to a new family. Two species are described, *B. radians* and *B. semicinctus.* They were from the Tertiary beds of the Wahsatch group, near Evanston, Utah, where they were obtained by Dr. F. V. Hayden. The beds are inferior to the Bridger group, and are supposed to be Lower Eocene. Prof. Cope writes us, that by the printer's neglect, the date to his paper is wrong; it should be, as above given, Feb. 16th.

8. *Illustrated Catalogue of the Museum of Comparative Zoölogy. Supplement to the Ophiuridæ and Astrophytidæ;* by THEODORE LYMAN.—In this little volume, which will be heartily welcomed by those zoölogists who have been obliged to form their ideas of the new deep-sea *Ophiuridæ* discovered by Mr. Pourtales in the Florida Straits, from Mr. Lyman's descriptions in the tenth Bulletin of the Museum of Comparative Zoölogy, is included: 1st, a list of publications in this part of actinology, published since 1865, to which is added some papers not included in the previous list;* 2nd, descriptions of one new genus (*Ophiomaza*) and five new species of Ophiuridæ (*Ophiomaza*, *Ophiothela*, *Ophiocnida*, *Ophioglypha*, and *Ophiomastix*); 3rd, a note on nomenclature and classification; 4th, two plates, representing in an analytical manner the new species mentioned above, and all the new genera and some of the new species established by the author in his preliminary report.

* Among these is a little pamphlet by Mr. Duchassaing (Animaux Radiaire des Antilles, 1850). Owing to the kindness of Mr. Rüse, I was well acquainted with this pamphlet before the publication of my Additamenta, part ii, and I have cited it in my other papers on the West Indian Echinodermata; but being totally incapable of guessing what species were really hidden under the names most absurdly applied, or under the completely inexplicable diagnoses, I thought it best to let this part of Mr. Duchassaing's on the whole not highly creditable publication rest in darkness; the more so, as the attempt I made, through Mr. Rüse, to procure the original specimens of Mr. Duchassaing's Ophiuridæ, failed altogether, and I was told that they had not been preserved at all. Now I learn from Mr. Lyman (in a letter dated Dec. 11, 1871), that he has discovered the greater part of Duchassaing's species in the collection of the late Mr. Michelin (now in the "Jardin des Plantes"), and has been able to identify them. Of course I quite agree with Mr. Lyman that "the short Latin descriptions are so incomprehensible and vague," that the claim of priority for Duchassaing's new species can without any injustice or inconvenience be totally disregarded; fortunately the species that might make such a claim are very few.

Respecting the plates—whose execution leaves nothing to be desired—the only thing I have to say, is to give vent to a gentle sigh that a greater number has not been given; several species that are now only figured from one side might otherwise have been figured from both; but as the author has no doubt done in this respect what he could, or what he deemed necessary for enabling the student to form a fair conception of the new genera, we must be grateful for what we have got, and not grumble that he did not satisfy our thirst for information in a more copious manner. I would also ask permission to intimate that it would have been more convenient for the student if the descriptions of the new genera and species had been reprinted from the "Bulletin," as he will now be obliged to seek the figures and descriptions in two different works; but perhaps a future number of the Catalogue will embrace them, as well as the other new observations of Mr. Lyman on this branch of the animal kingdom.

On some of the new genera established in these two works, and of which a full conception could be formed only after the publication of figures illustrating their character, I have a few remarks to make. I do not see in what respect *Ophiomaza* is generically different from *Ophiocnemis;* its diagnosis will apply equally well to *Ophiocnemis obscura* Ljn.; in fact, I entertain a strong suspicion that this species is identical with *O. cacaotica*, and I see no reason to separate it generically from *O. marmorata.* Further, *Ophiomitra* is separated from *Ophiacantha*, because of its "naked scales and conspicuous radial shields" as opposed to "the long, very narrow radial shields, covered, together with the disk, by a thick skin," in the latter genus. But the small difference that may perhaps exist as to the thickness of the skin, in which the grain or thorn-bearing scales are imbedded in both genera, is certainly not of generic importance, and the radial shields are often partly visible quite in the same manner in *Ophiacantha spinulosa* as in *Ophiomitra.* The diagnosis of this genus, therefore, agrees very well with *Ophiacantha*, and I have failed to find in the detailed descriptions of the species anything to prevent its union with the latter. As far as I can judge from the description and figure, *Ophiothamnus* also agrees very well with *Ophiacantha*, the differences being I think, only of specific value. Not having access to the species or specimens myself, it is not my intention to enter into further details on this occasion, but only to state my personal impression, that these three presumed new genera are not distinct genera at all, in the commonly accepted sense of the word; and my belief that if, after this suggestion, Mr. Lyman will reconsider the question, on the base of the lately acquired fuller knowledge of the genus *Ophiacantha*, he will feel himself satisfied as to its confluence with *Ophiomitra* and *Ophiothamnus.*

[This notice, by Dr. Lütken of Copenhagen, will be continued in the next number of this Journal.]

III. Astronomy.

1. *Eclipse of the Sun, Dec.* 12, 1871.—Extract of a letter of Dr. Janssen to Prof. Newton, dated Sholoor, Nilgherry, Dec. 26th, 1871.—I have the honor to send you the results of my observations upon the eclipse of the sun on the 12th of Dec., made at Sholoor, Nilgherry, Hindostan.

I was favored with a sky of almost absolute transparency. This circumstance, and the wholly novel optical arrangements which I had made, have enabled me to establish facts about the corona which prove its solar origin, at least for the greater part.

In my telescope * the spectrum of the corona does not appear as continuous, but is remarkably complex. I have found in it:

I. The bright rays of hydrogen gas, which forms the principal element of the protuberances and the chromosphere;

II. The bright green ray, previously remarked in the eclipses of 1869 and 1870, and certain other fainter ones;

III. The dark rays of the ordinary solar spectrum, particularly D. These rays are much more difficult to detect.

My observations prove that, independently of the cosmical matter which should be found near the sun, there exists, about this body, an atmosphere of great extent, exceedingly rare, and with a hydrogen base. This atmosphere, which, doubtless, forms the last gaseous envelope of the sun, is fed from the matter of the protuberances which is shot up with great violence from the interior of the photosphere. But it is distinguished from the chromosphere and the protuberances by a much smaller density, a lower temperature, and perhaps by the presence of certain different gases. There is a reason then for distinguishing this new solar atmosphere. I propose to call it the *coronal atmosphere*, a name which indicates that it is this atmosphere which produces the large part of the phenomena hitherto denoted by the name *solar corona*.

In announcing this result, I do not, on my part, forget how much we are indebted to the labors of those who have prepared the way for it, especially to the labors of the American astronomers who observed the eclipses of 1869 and 1870.

I do not doubt that the observations of others this year will agree with mine.

2. *On the Solar Eclipse of December* 12, 1871; by J. Norman Lockyer.— * * * As the mail, the first available one after the eclipse, leaves this place to-day, I must lose no more time in recording preliminaries. I will therefore at once state the general arrangements of the parties, and what I at present know of the observations. The stations and observers as finally arranged were as follows:—

Bekul—Analysing Spectroscope, Capt. Maclear and Mr. Pringle. Polariscope, Dr. Thomson. Photography, Mr. Davis.

Manantoddy—Analysing Spectroscope, Mr. Friswell; Integrating Spectroscope, Mr. Abbay.

* This telescope has an opening of 37 centimeters, and a focal distance of only $1^{m}{\cdot}42$. The images of objects are 12 to 16 times as bright as in an ordinary astronomical telescope. The spectroscope was so constructed as to use all this light.

Poodocottah—Spectroscope, Professor Respighi; Sketches of Corona, Mr. Holiday.

Jaffna—Integrating Spectroscope, Capt. Fyers and Mr. Ferguson; Polariscope, Capt. Tupman and Mr. Lewis; Photography, Captain Hogg.

Trincomalee—Spectroscope, Mr. Moseley.

Besides these observers, we had at Bekul the valuable assistance of General Selby, commanding the troups in Canara and Malabar (for whose help in supplying guards, tents, &c., the friends of science cannot be too thankful), Colonel Farewell, Judge Walhouse, and others, in sketching the corona. At all stations, of course, most precious help in various ways was given by all present who volunteered for the various duties, though some of them lost a sight of the eclipse in consequence. Among those who helped in this way at Bekul were Mr. McIvor, Mr. Pringle, Captain Bailey (who timed the eclipse), Mr. Cherry, and Captain Christie, the Inspector of Police, whose presence there turned out to be of the most serious value, for the natives seeing in the eclipse the great Monster Rahoo devouring one of their most sacred divinities, not only howled and moaned in the most tremendous manner, but set fire to the grass between our telescopes and the sun to propitiate the representative of the infernal gods. Captain Christie, with his posse of police, stopped this sacrifice at the right moment, and no harm was done.

Now for the observations. Perhaps I may be permitted to begin with my own, as at the present moment I know most about them. I determined to limit my spectroscopic observations to the spectrum of a streamer, and to Young's stratum, thereby liberating a number of seconds which would enable me to determine the structure of the undoubted corona with a large refractor, to observe the whole phenomena with the naked eye, and through a train of prisms with neither telescope nor collimator, and finally with a Savart and biquartz. I found the 120 seconds gave me ample time for all this, but owing to a defect in the counterpoising of my large reflector, which disturbed the rate of my clock, I missed the observation of the bright line stratum (assuming its existence) at the first contact. At the last contact Mr. Pringle watched for it and saw no lines.

Having missed this, I next took my look at the corona. It was as beautiful as it is possible to imagine anything to be. Strangely weird and unearthly did it look—that strange sign in the heavens! What impressed me most about it, in my momentary glance, was its serenity. I don't know why I should have got such an idea, but get it I did. There was nothing awful about it, or the landscape generally, for the air was dry and there was not a cloud. Hence there were no ghastly effects, due generally to the monochromatic lights which chase each other over the gloomy earth, no yellow clouds, no seas of blood—the great Indian Ocean almost bathed our feet—no death-shadow cast on the faces of men. The whole eclipse was centered in the corona, and there it was, of

the purest silvery whiteness. I did not want to see the prominences then, and I did not see them. I saw nothing but the star-like decoration, with its rays arranged almost symmetrically, three above and three below two dark spaces or rifts at the extremities of a horizontal diameter. The rays were built up of innumerable bright lines of different lengths, with more or less dark spaces between. Near the sun this structure was lost in the brightness of the central ring.

But from this exquisite sight I was compelled to tear myself after a second's gazing. I next tried the spectrum of a streamer above the point at which the sun had disappeared. I got a vivid hydrogen spectrum, with 1474 (I assume the point of this line from observation) slightly extended beyond it, but very faint throughout its length compared with what I had anticipated, and thickening downwards, like F. I was, however, astonished at the vividness of the C line, and of the continuous spectrum, for there was no prominence on the slit. I was above their habitat. The spectrum was undoubtedly the spectrum of glowing gas.

I next went to the polariscope, for which instrument I had got Mr. Becker to make me a very time-saving contrivance—a double eye-piece to a small telescope, one containing a Savart and the other a biquartz. In the Savart I saw lines vertical over everything—corona prominences, dark moon, and unoccupied sky. There was no mistake whatever about this observation, for I swept three times across and was astonished at their unbrokenness. I next tried the biquartz. In this I saw wedges, faintly colored here and there; a yellowish one here, a brownish one there, with one of green on each side the junction, are all the colors I recollect. Then to the new attack—the simple train of prisms which, the readers of *Nature* know, Professor Young had thought of as well as myself; its principle being that, in the case of particular rays given out by such a thing as the chromosphere, or the sodium vapor of a candle, we shall get images of the thing itself painted in that part of the spectrum which the ray inhabits, so to speak, we shall see an image for each ray, as if the prisms were not there. What I saw was four exquisite rings, with projections where the prominences were. In brightness, C came first, then F, then G, and last of all 1474! Further, the rings were nearly all the same thickness, certainly not more than 2′ high, and they were all enveloped in a line of impure continuous spectrum.

I then returned to the finder of my telescope, a $3\frac{3}{4}$ inch, and studied the structure of the corona and prominences. One of the five prominences was admirably placed in the middle of the field, and I inspected it well. I was not only charmed with what I saw, but delighted to find that the open-slit method is quite competent to show us prominences well without any eclipse. I felt as if I knew the thing before me well, had hundreds of times seen its exact equivalent as well in London, and went on to the structure of the corona. Scarcely had I done so, however, when the signal was given at which it had been arranged that I was to do this in

the 6-inch Greenwich refractor. In this instrument, to which I rushed, for Captain Bailey had just told us that we had "*still* 30 seconds more"—which I heard mentally, though not with my ears, as "*only* 30 seconds more"—the structure of the corona was simply exquisite and strongly developed. I at once exclaimed, "like Orion!" Thousands of interlacing filaments varying in intensity were visible, in fact I saw an extension of the prominence-structure in cooler material. This died out somewhat suddenly some 5′ or 6′ from the sun (I could not determine the height precisely), and then there was nothing; the rays so definite to the eye had, I supposed, been drawn into nothingness by the power of the telescope; but the great fact was this, that close to the sun, and even for 5′ or 6′ away from the sun, there was nothing like a ray, or any trace of any radial structure whatever to be seen. While these observations were going on, the eclipse terminated for the others, but not for me. For nearly three minutes did the coronal structure impress itself on my retina, until at last it faded away in the rapidly increasing sunlight. I then returned to the Savart, and saw exactly what I had seen during the eclipse; the vertical lines were still visible!

Captain Maclear has promised to forward to you himself an account of his observations. I need only here therefore refer to their extreme value, adding what I should have stated before, that I saw the bright lines at the cusps, as he was so good as to draw my attention to them. I am, however, not prepared to say that they were visible through a large arc of retreating cusp.

Dr. Thomson confined his observations to the polariscope, using the Savart. He states that his observations were identical with my own.

Mr. Davis's photographic tent was below the cavalier in which our telescopes had been erected; and immediately after the observations I have recorded were over, I went down to see what success had attended his efforts. I was hailed when half-way there with the cheering intelligence "five fine photographs," and so they are, those taken at the beginning and end of the eclipse being wonderfully similar, with, I fancy, slight changes here and there; but on this point I speak with all reserve until they have been examined more carefully than the time at our disposal has permitted, and until they have been compared with those taken at Ootacamund, Avenashi, and, I hope, at Jaffna and Cape Sidmouth.

This exhausts the principal work done by the Bekul party, with the exception of the sketchers, with General Selby at their head, who have recorded most marked changes in the form of the outer corona, and Mr. Webster, who was so good as to photograph the eclipse from a fort some eight miles away, with an ordinary camera, and obtained capital results.

Next a word about the Poodocottah, the other fortunate Indian party. Prof. Respighi has promised to send his results to you with this. About Mr. Holiday's labors I know nothing, except that he has obtained three sketches.

Concerning the Ceylon parties, I give you a verbatim extract from the telegrams. From Jaffna: "Exceedingly strong radial polarisation, 35′ above the prominences; corona undoubtedly solar to that height, and very probably to height of 50′." From Trincomalee Mr. Moseley informs me that he carefully watched for Young's bright line stratum, and did not see it, and that 1474 was observed higher than the other line.

This is the sum total of the information which has at present reached me. It is clear there are discordances as well as agreements, the former being undoubtedly as valuable as the latter. It remains now to obtain particulars of all the observations of all the parties, before a final account can be rendered of the eclipsed sun of 1871. This, of course, will be a work of months; but if all goes well, I trust to obtain information shortly of the outlines of the work done by the Indian observers and M. Janssen, as I am now remaining in India for that purpose, and this I will communicate to *Nature* by the earliest opportunity. In the meantime I hope the good people at home will think we have done our duty, and that all the members of the Government Eclipse Expedition of 1871 will soon be safely with them to give an account of their work.—*Nature*, *Jan.* 18.

Ootacamund, Dec. 19, 1871.

3. *Inauguration of the Cordoba Observatory.*—This event, one of great importance to astronomical science, as well as to the country which has the honor of establishing the observatory, took place on the 24th of October last. The Standard of Buenos Ayres, of October 27th, contains an account of the inauguration. together with the address on the occasion of Professor B. A. Gould, the director of the observatory. The address is published in English, but was delivered in Spanish. The Standard says, by way of introduction:

"The formal inauguration of the Argentine Observatory at Cordoba took place with all the pride, pomp and circumstance of glorious science, on Tuesday last, in the presence of the dignitaries of the land and the *élite* of Cordoba. The Bishop took the initiative by blessing the enormous telescope, the largest instrument of the kind on the South American continent. Professor Gould then stepped forward and pronounced the following remarkable address; we make no apology for its length, but commend it to the attentive perusal of our readers. It is a document for history, beautiful in its composition, and highly felicitous in its remarks. Even amongst the audience every pause of the Professor was welcomed with applause."

Most of the facts in the very able address have been already communicated to this Journal by Dr. Gould. We cite the following paragraphs:

"In the year 1751 a French astronomer, Abbé de la Caille, visited the Cape of Good Hope for the purpose of determining the positions of the principal southern stars. With a little telescope of comparatively insignificant dimensions, he succeeded in obtain-

ing the materials for so complete a catalogue—as far as the limit of brightness which his telescope permitted—and in determining the positions of those stars so well, that this catalogue of about 9,800 stars constitutes to-day the chief reliance of astronomers for their knowledge of a large portion of the southern sky. Since that time a permanent observatory has been established by the British Government at the same place, and a large number of valuable observations have been made by various eminent men. Other observatories in the southern hemisphere have been founded at Paramatta, Santiago de Chile, and Melbourne, all of which have contributed essentially to our knowledge of the southern sky; as also has the observatory at Madras, which, although north of the equator, commands a view of the greater portion of the southern heavens. Yet how much remains to be done in this direction will be very evident when I state that, while the numbers of stars in the northern hemisphere whose positions and magnitudes have been determined cannot fall short of about 330,000, the number in the southern hemisphere whose observed places have been published does not probably exceed 50,000. But this is not all. The greater portion of those which have been observed lie in that part of the sky which is clearly visible in Europe: and if we consider the regions beyond 30 deg., there are scarcely 13,000 southern stars whose places and magnitudes have been determined and made available for scientific use, while the corresponding portion of the northern sky contains something like 164,000 such stars. The late astronomer Gilliss, the originator of what is now the National Observatory of Chile, as well as of the Naval Observatory at Washington, of which latter he was the Director at the time of his death, devoted much time and labor to the effort to supply this pressing need; and while at Santiago, he made the requisite observations for determining the places of no less than 23,000 stars within 40 deg. of the South Pole. The computations were carried on at the expense of the U. S. Government, and were nearly completed at the time of his death, in 1865, after which the work was unfortunately suspended: but I have lately received the gratifying assurance that the calculations are now to be completed, and the resulting catalogue published by the Observatory at Washington. * * * * * * *

Nor has the progress of the work failed to afford its due share of discoveries. It has given us the knowledge of a considerable number of stars which possess the singular character that their brightness is not always the same, but undergoes systematic variations. Some have been seen to rise to considerable brilliancy, and then fade away until telescopes of some power are needed for rendering them visible. Others still are now found to possess a brilliancy decidedly greater or decidedly less than that which has been assigned to them by more than one astronomer in times past. Such stars must be carefully watched, and the fact of any regular and periodic fluctuation in the amount of their light either established or disproved. Of such cases there are already

many on our records, thanks to the assiduity and zeal of the assistant astronomers, no one of whom has failed to make manifest the existence of several. One of those most remarkable for the rapidity of its changes is a little star in the constellation "Musea," which is invisible to the unaided sight during one half its period, and visible during the other half, while the observations of Mr. Rock show that it goes through all its changes within the short interval of $21\frac{1}{4}$ hours. Another in the constellation of the "Southern Triangle," which has been regularly observed by Mr. Davis, exhibits regular fluctuations of light, comprised within a period of about $3\frac{1}{2}$ days, similarly alternating between visibility and invisibility. These two exhibit the most rapid changes of any of the stars which we have hitherto observed; but there are others not less interesting, observed not only by the two gentlemen mentioned, but also by Messrs. Thome and Hathaway, who are likewise pursuing these investigations with much success.

The transparency of the sky of Cordoba upon favorable nights may be judged of by a single additional fact. You will find in the treatises on astronomy, as I have already mentioned, the total number of stars in the entire heavens visible to the naked eye, estimated at from 5,500 to 6,000. Now, we have already recorded in the "Uranometria Argentina" the places of not less than 6,400 stars, visible to the unaided sight of every one of our observers, in the southern hemisphere alone; while in the 1st 10 deg. of the northern hemisphere we have 800 more, making in all at least 7,200 stars; so that we are justified in the belief that were the sky equally transparent for astronomers in the northern hemisphere, the total number of stars visible to the ordinary eye would be estimated at certainly not less than 11,000, instead of half that number."

IV. Miscellaneous Scientific Intelligence.

1. *Exploration in Southern Nevada and Arizona.*—An expedition under the auspices of the Department of Engineers, U. S. A., for the exploration of unexplored territory in Southern Nevada and in Arizona, and placed under the immediate charge of Lieut. Geo. M. Wheeler, took the field early in May last, and continued its labors until December. The snow blockade on the Rocky Mountains and other difficulties delayed, until late in January, the arrival of the scientific corps in Washington, where they are now engaged in preparing an official report. The principal object of the expedition was to map and describe a portion of inhospitable territory, of which our previous knowledge was limited to the incoherent accounts of a few bold "prospectors." With this view, a large topographical force was organized, and though it was afterward reduced from seven to three members, an average of four topographical parties was maintained through the season.

Messrs. E. P. Austin and A. R. Marvine were the astronomers of the expedition, Dr. W. J. Hoffman the naturalist, Messrs. F.

Bischoff and J. Köhler the collectors, and Messrs. G. K. Gilbert and A. R. Marvine the geologists. The entire company, including escort, &c., numbered eighty or ninety persons, and was divided into two principal parties, meeting at designated points once in every month. These were subdivided as circumstances allowed, so as to deploy over as great an area as possible. Leaving the Central Pacific Railway at Carlin and Battle Mountain in Northern Nevada, the parties moved rapidly southward to Belmont, where the main exploration commenced. Thence to the Colorado the lines of survey were spread in a connected web over the entire width of Nevada, and even into California and Utah. With some contraction of its field, the survey was carried south across Arizona, and terminated at Tucson. A small party with boats explored the Colorado from Fort Mojave 200 miles to the mouth of Diamond Creek, more than 100 miles above the point attained by Lieut. Ives, and 40 above the mouth of the Big Cañon. Numerous photographs were made in the celebrated Black and Big Cañons, as well as at many other points of interest. Besides the usual sextant observations, accurate astronomical determination, by zenith telescope, was made of the latitude and longitude of six points. Barometric profiles and meteorological observations were made throughout.

In natural history extensive collections were made, which cannot fail to afford a considerable number of new species, and a mass of information has been acquired in regard to the distribution of animals and plants. In geology material has been collected for a proximate map of the region explored, connecting the work of Newberry, Blake and Antisell in Arizona with that of King on the fortieth parallel.

While returning by stage, Mr. P. W. Hamel, chief topographer, and two other members of the expedition, were killed by Apaches. Mr. Hamel had a deserved reputation as a topographer of rare skill, and his loss was a great one to the cause of geographical science. The results of his last work, however, are not entirely lost, as his notes were carefully kept, and will be of great use in the compilation of the map.

A preliminary report and map will be published in a few weeks.

2. *Notice of the Earthquake in New England of January 9th;* by Prof. C. G. Rockwood. (Communicated.)—At a few minutes before 8 P. M. of January 9, 1872, an earthquake was experienced over a considerable portion of eastern New England and the St. Lawrence valley. It was felt along the St. Lawrence river to a distance of 200 miles N. E. and 60 miles S. W. from Quebec, and at various points of New Hampshire and Maine between this locality and the Atlantic coast at Portland and Belfast, Me. The disturbance was greatest at Quebec, where some walls were cracked and large fissures were caused in the ice bridge over the river. The shock occurred there at $7^h\ 54^m$ P. M., and lasted about thirty seconds, being accompanied by a low rumbling sound. At Lancaster, N. H., there were two distinct shocks, each lasting but a

few seconds, and the last being the more violent. The shocks were nowhere very severe, and being of very short duration, were generally unnoticed, except by those who happened to be favorably situated to perceive them. The direction of the vibrations was well defined and approximately from west to east. Probably the true direction was from a point somewhat *south* of west, which would coincide nearly with the course of the St. Lawrence river, and with the shorter diameter of the region shaken.

At Quebec and at Bangor, Me., slight tremors were also felt about 3 P. M. and 11 P. M. of the same day.

Brunswick, Me., Feb. 3, 1872.

3. *Monthly Rainfall at San Francisco;* by PLINY EARLE CHASE, Professor of Physics in Haverford College. (Communicated to the Meteorological Section of the Franklin Institute, Jan. 1, 1872.)—Mr. Thomas Tennent has published a chart, compiled from his own observations, of the monthly amounts of rain in San Francisco for twenty-two years, from July 1, 1849, to July 1, 1871. I have grouped the amounts in seven short periods, and computed the normal ordinates (N) for the several curves, which are given, together with the observed amounts (R), in the following table.

SAN FRANCISCO RAINFALL.

	1849-52.		1852-55.		1855-58.		1858-62.	
	R	N	R	N	R	N	R	N
July,	----	3	----	3	·02	2	·26	6
Aug.	----	9	·05	6	·05	3	·18	4
Sept.	1·03	41	·61	23	·07	16	·05	19
Oct.	3·35	111	3·33	65	1·38	57	3·70	64
Nov.	12·03	196	7·93	116	6·47	136	12·65	142
Dec.	14·35	228	16·33	176	13·65	219	23·41	220
Jan.	9·64	191	11·47	193	16 21	249	29·75	248
Feb.	2·45	155	14·23	194	10·92	217	19·17	208
Mar.	13·15	136	13·01	185	8·77	156	13·29	140
Apl.	1·95	90	13·49	142	4·49	92	4·65	83
May,	·99	34	2·28	74	1·12	40	6·15	46
June,	----	8	·08	21	·20	12	·22	21

	1862-65.		1865-68.		1868-71.		1849-71.	
July,	----	5	----	2	----	1	·28	3
Aug.	·21	3	----	1	----	3	·49	4
Sept.	·04	20	·39	11	·15	12	2·34	20
Oct.	·53	84	·46	58	1·44	44	14·19	67
Nov.	9·38	187	10·95	155	2·80	115	62·21	149
Dec	13·06	252	26·43	249	12·03	206	119·26	221
Jan.	10·60	229	25 54	267	13·31	257	116·52	235
Feb.	4·53	161	15·45	210	12·44	235	79 19	200
Mar.	4·32	113	10 92	135	6.43	171	69·89	148
Apl.	4 12	82	4·79	73	5·65	101	39·14	94
May,	1·64	48	1·49	31	·49	44	14·16	45
June,	----	17	·27	9	·02	11	·79	15

There is so much similarity between the different curves, their general character is so much like that of the Lisbon curves, and they accord so nearly with the annual temperature curve, that they may reasonably be regarded as typical, and the daily records may

probably furnish materials for more minute and detailed profitable investigation.

Among the deductions in my paper on the "tidal rainfall of Philadelphia" (Proc. Amer. Phil. Soc., x, 530), were the two following:

"(1.) The tidal rainfall, like the ocean tides, is affected by 'establishments,' which depend upon ocean currents, mountain ranges, prevailing winds, and other climatic influences.

"(2.) It is also, like the ocean tides, more marked in low than in high latitudes."

These inferences are strikingly corroborated by the Lisbon records, and I look confidently for equally striking additional confirmation from observations on our Pacific coast. Moreover, I think that my previous discussions, combined with generalizations from the meteorological reports of the Signal Service Bureau and with well known tidal laws, are sufficient to justify the following predictions.

(1.) The tidal rainfall will generally be found more strongly marked on the western shores of the several continents, than in the same latitudes on the eastern shores.

(2.) When the rainfalls, at any given station, are grouped both in accordance with the age of the moon and the direction of the wind which brings the rain, opposition of winds will be found to affect the tidal curves similarly to opposition of direction from large bodies of water.

(3.) A certain degree of apparent opposition will be found to exist between the lunar influence upon the upper and lower cloud strata, dependent upon the normal difference of position in the tidal crests of deep and shallow-fluid envelopes.

(4.) The satisfactory determination of the lunar influence upon atmospheric currents will be found practicable, although vastly more laborious than the determination of the laws of tidal rainfall. Glaisher has already shown that there is such an influence, but there have been no published discussions of its amount or general character.

4. *Meteor in Mexico.*—For the following communication the Journal is indebted to the favor of Prof. Henry, Secretary of the Smithsonian Institution.

The observations relate to the meteor of the 22nd of last month [in 1871, but the month not stated in the communication] and are from an article in the "Corréo del Comercio," published by José de la Vega, director of the telegraphic line from Vera Cruz to Mexico.

Being in the telegraph office, we have been enabled to follow telegraphically the meteor from one point to the other. The following are the reports received.

Mexico.—At a quarter past eight o'clock P. M., a red streak appeared in the blue sky, and turned afterwards into a whitish luminous band. It moved from west to east with a slight inclination towards the W. S. W. and E. N. E., and lasted ten minutes.

Apizaco.—When the advice reached me, I could only see a handsome light, which vanished in the horizon. It may have lasted about ten minutes.

Puebla.—After eight o'clock a fire-ball was seen to start from the direction of Popocatepetl, running toward the top of Orizaba and leaving in its course a cloud of dense reddish smoke.

Huamantla.—At fourteen minutes past eight o'clock there was seen a fire-ball about the size of the face of a large clock, which coming from the west disappeared in the horizon toward the east, somewhat inclining to the south. It looked as if coming from the moon, and illuminated extraordinarily the earth, leaving in the sky a track of light which lasted about ten minutes and showed the course of the inflamed body.

San Andres.—The meteor has been observed here, and left a line from east to west.

Perote.—At forty minutes past eight o'clock the meteor was observed here and lasted four minutes, leaving in its course a luminous band.

Tehuacan.—At a quarter to nine o'clock the meteor was observed here. It moved from west to east, looked like an inflamed cannon-ball, and left in its course a luminous track which remained perfectly distinct for the space of ten minutes, and then gradually disappeared about five minutes past nine o'clock.

Jalancingo.—As a very dense fog was prevailing, we were able to see only for a moment a light in the sky in the form of a rainbow.

Jalapa.—At forty-five minutes past eight o'clock there was noticed here a whitish luminous band only; but other persons saw the meteor itself.

Vera Cruz.—At nine o'clock the meteor was observed here. It moved from west to east, and lasted about a minute. Its wake was brilliant and extensive, lasting about five minutes.

Forty-five minutes elapsed from the moment the meteor was observed at Mexico, till the moment it made itself visible at Vera Cruz, three hundred and twenty kilometers distant.

I shall be very glad if this information may serve as a means of ascertaining at what distance from the earth the meteor occurred, and what was the velocity of its motion.

5. *Catalogue of the Meteoric Collection of* CHARLES UPHAM SHEPARD, deposited in the Wood's building of Amherst College, Amherst, Mass.—Prof. Shepard has one of the largest collections of meteorites in the world. It embraces, according to his enumeration in this catalogue, 146 different meteoric stones and 93 meteoric irons. The heaviest specimen of the irons is one from Aeriotopas, weighing 438 pounds, and the largest of the stones is that from New Concord, weighing 52 pounds.

Speaking in the latter part of the pamphlet of a collection of serpentine rocks from Havana (W. I.), which he had arranged in the same room, he introduces the name *Antillite* for a bronzite-like, serpentine mineral, which he supposes to be new,

an analysis affording the composition $\dot{S}i$ 39·30, $\dot{M}g$ 36·12, $\dot{F}e$ 6·79, $\dot{H}$ 16·79, with traces of $\dot{C}r$, $\dot{C}a$, $\dot{K}$. It is in dark greenish-brown laminæ, with a fibrous cleavage and also occurs massive infusible B. B. except on the edges. [The analysis affords very nearly the oxygen ratio for the protoxides, silica and water $3 : 4 : 2\frac{3}{4}$; or the composition of a ferriferous serpentine with excess of water.] Prof. Shepard observes that, among the serpentines, numbers of the series of specimens, even when several inches across, are *plainly pseudomorphs after chrysolite, amphibolite, augite and titanite; and that these pseudomorphs so abound in the matrix that they constitute the largest portion of the mass, and may be easily separated by a blow of the hammer.*

6. *The Rumford Medals.*—At the last annual meeting of the American Academy of Arts and Sciences held in Boston, May 30th, 1871, the Rumford premium was awarded to Mr. Joseph Harrison, Jr., of Philadelphia, "*for his method of constructing steam boilers, by which great safety has been secured.*" According to the directions of Count Rumford, this premium was given in two medals—one of gold and one of silver—together of the intrinsic value of three hundred dollars; and at the last monthly meeting of the Academy a formal presentation of the medals was made.

The medals presented to Mr. Harrison are the sixth award of the Rumford premium, made by the American Academy. The other awards have been as follows:—

In 1839 to Dr. Robert Hare, of Philadelphia, for his invention of the compound blow-pipe and his improvements in galvanic apparatus.

In 1862 to Mr. John B. Ericsson, of New York, for his caloric engine.

In 1865 to Professor Daniel Treadwell, of Cambridge, for his improvements in the management of heat.

In 1867 to Mr. Alvan Clark, of Cambridge, for his improvements in the manufacture of refracting telescopes, as exhibited in his method of local correction.

In 1870 to Mr. George H. Corliss, of Providence, for improvements in the steam engine.

It was directed by Count Rumford that the premium should be given "to the author of the most important discovery or useful improvement which shall be made and published by printing, or in any way made known to the public, in any part of the Continent of America, or in any of the American Islands, during the preceding two years, on Heat or on Light; the preference always being given to such discoveries as shall in the opinion of the Academy tend most to promote the good of mankind." In Count Rumford's original letter of donation, dated London, July 12th, 1796, besides the above, several other directions are given, with which the Academy found it impossible, or at least very inexpedient, to comply literally, and for this reason the premium was not awarded during a long series of years. The Academy is now

acting under a decree of the Supreme Judicial Court of the Commonwealth of Massachusetts, especially authorized by an Act of the Legislature of the State, approved by the Governor, March 16th, 1831. This decree enables them to award the premium at any annual meeting, and relieves them from the necessity of limiting it to discoveries or improvements made during the two years immediately preceding the award.

All interested in the subject will find a full statement of the facts in the Life of Count Rumford, by the Rev. George E. Ellis, D.D., recently published for the Academy (in connection with an edition of Rumford's complete works) by Claxton, Remsen and Haffelfinger, 819 and 821 Market street, Philadelphia.

A committee consisting of seven Fellows, called the Rumford Committee, is annually appointed by the Academy, and it is their duty to investigate all claims for the Rumford premium. The premium is awarded only on the recommendation of this committee, and at the "annual meeting" of the Academy, held on the fourth Tuesday of May. The Rumford fund would enable the Academy to give the medals every year; but the premium can be awarded only for a new discovery in light and heat, or a substantial improvement in the application of these agents to the arts of life, whose usefulness has been tested by experience. All communications on the subject of the Rumford premiums should be addressed to the Chairman of the Rumford Committee, American Academy of Arts and Sciences, Boston.

7. *Light of the bottom of the Ocean.*—In the Annals and Magazine of Natural History for January, W. C. M'Intosh discusses the question whether the idea that the bottom of the ocean is rendered light by the phosphorescence of its life, and concludes that the abysses of the ocean are not better supplied in this respect than the littoral region or the shallow Laminarian zone—indeed, than the surface of the sea itself. The question whether this luminosity is given to marine animals for the purpose of preying or being preyed upon, suggested in the Reports of the dredging expeditions of H. M. S. Porcupine, is decided adversely.

Mr. McIntosh also combats the conclusion of Dr. Carpenter that the turbidity of the lower waters of the Mediterranean renders the bottom barren of life, pointing out many facts with regard to the growth of life, in great variety, over the muddy bottom of seas.

8. *Manna from a Linden in the Vosges.*—Boussingault has made the following observations on a manna obtained from the leaves of an old linden, in the Vosges. In composition it is almost identical with that of Mt. Sinai, studied by Ehrenberg and Berthelot. It contains, in round numbers, 55 p. c. of cane sugar, 25 of inverted sugar, and 20 of dextrine. It occurred on the upper part of the tree, not the lower. Although there were other trees of the same kind in the vicinity, only this one afforded the manna. The manna of Mt. Sinai was attributed by Ehrenberg to the puncture of an insect; but Boussingault thinks that this is not the source of it in the case of the linden manna; for he had seen no in-

sect on the tree which could have produced such a result.—*Acad. Sci. Paris, L'Institut, Jan.* 10.

9. *Hailstones of salt and sulphide of iron.*—Prof. KENNGOTT, of Zurich, states that in a hailstorm, lasting five minutes, on the 20th of last August, the stones, some of which weighed twelve grains, consisted essentially of common salt, mainly in imperfect cubical crystals. He supposes that the salt had been taken up from the salt plains of Africa, and brought over the Mediterranean.

Hailstones containing each a small crystal of sulphide of iron are reported as having fallen recently, by Prof. Eversmann of Kasan. The crystals were probably weathered out of some rocks in the vicinity.—*Nature, Jan.* 11.

10. *Temperature of the Sun.*—The temperature of the sun, according to Secchi's calculations, is at least 10,000,000° C.; and according to Mr. Spœrer's, 27,000° C.; while Pouillet placed it between 1461° and 1761° C. Mr. Vicaire, in a note to the French Academy of Sciences, objects to Secchi's use of Newton's law of radiation, because applicable only in case of low temperature, and, accepting that of Dulong and Petit, arrives at the more probable conclusion that the temperature does not exceed 3000° C. (5400° F.). He observes that the greatest heat of the oxyhydrogen blowpipe is 2500° C. (4500° F.), and the highest furnace heat not above 2000° C. (3600° F.).

V. MISCELLANEOUS BIBLIOGRAPHY.

1. *Catalogue of Photographic Illustrations by* WM. H. JACKSON, Photographer to the Survey of the Territories under Dr. F. V. HAYDEN, Department of the Interior, Washington, D. C., 1871.—This catalogue contains the titles of over four hundred Rocky Mountain photographs, mostly eight by ten inches in size, representing scenery of geological as well as general interest, Indian villages, Indians, etc. We have seen eighteen of them taken in the Geyser region of the Yellowstone, and they are admirable as photographs, and wonderful in beauty and interest, supplementing well the articles by Dr. Hayden in this Journal. By their high character, they speak well for the rest in the list. They represent lakes and boiling springs, basins and cones, and geysers, quiet and in action, and show even the texture of the deposits of silica and carbonate of lime which constitute the cones and the borders of the basins. They enable the geologist to realize what kind of deposits springs or chemical depositions make, presenting nothing to favor the idea that beds like those of ordinary even-grained limestones, however pure and free from fossils, are possible results of such action.

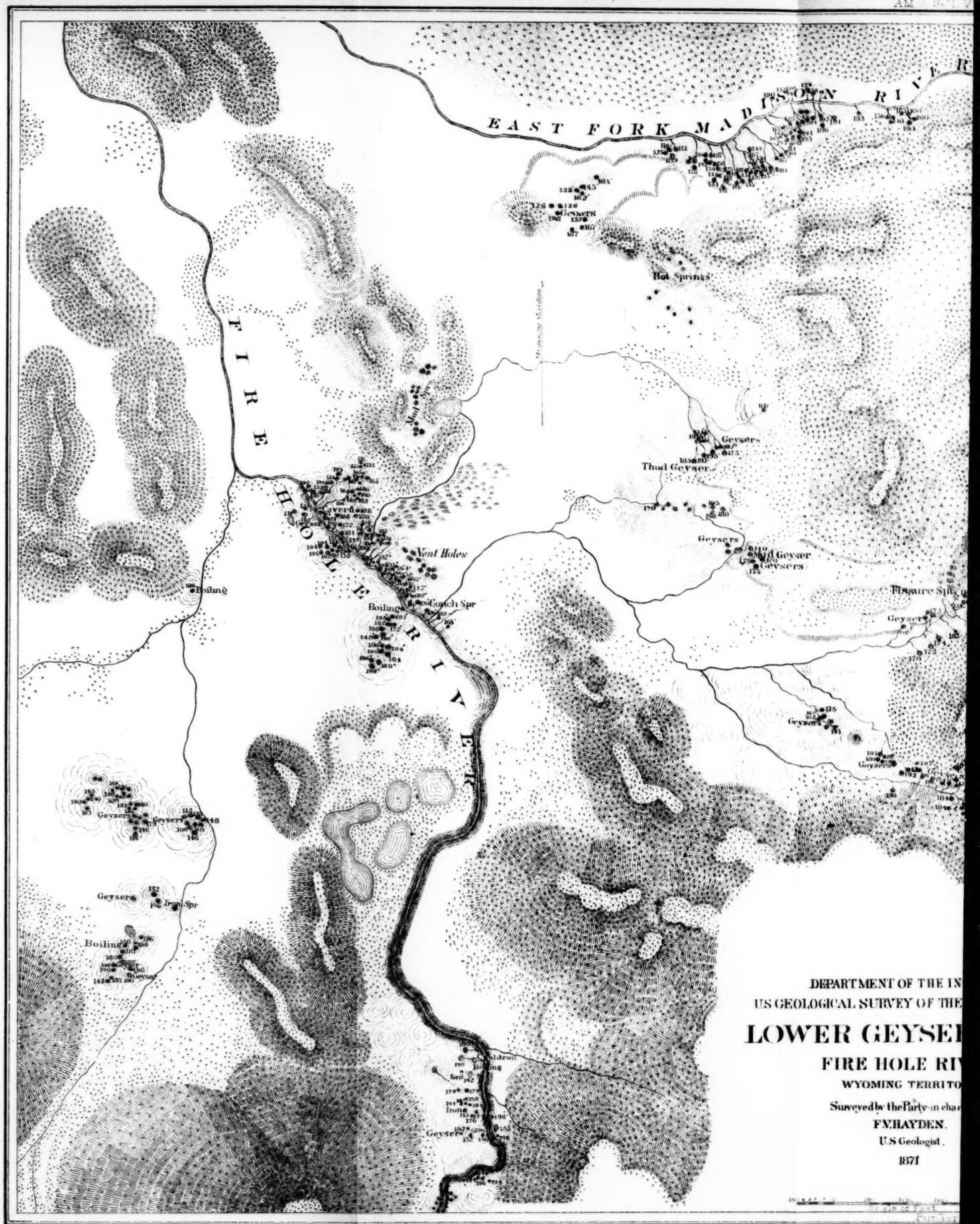
2. *Fireside Science. A Series of Popular Scientific Essays upon Subjects connected with Every-day Life;* by JAMES R. NICHOLS, A.M., M.D. New York, 1872. 12mo, pp. 283. (Hurd & Houghton.)—Dr. Nichols has made a valuable contribution to the fireside literature of science in these essays, which present in a clear manner many important facts and principles in familiar

language, adapted to the tastes of all intelligent people. In some of the essays the author states important results from his own researches, as in his "Experiments with air furnaces," and the agricultural papers. Many of these essays, in substance at least, have already appeared in the author's Boston Journal of Chemistry. S.

3. *A Treatise on Localized Electrization, and its applications to Pathology and Therapeutics;* by Dr. G. B. DUCHENE. Translated from the 3d edition of the original, by HERBERT TIBBITS, M.D., Royal Coll. Phys., London. With numerous illustrations and notes and additions by the Translator. Philadelphia, 1871. 8vo, pp. 322. (Lindsay & Blakiston.)—This is Part First of the great work of Duchene on Localized Electrization, and its translation is a good service done to English and American students. Its value is by no means confined to the physiological or medical student, as nowhere else can the physicist and chemist find a better statement of the fundamental principles and structural details of electrical apparatus and methods of producing electrical currents. The publication of the original work was suspended by the investment of Paris by the German army, so that the translation appeared before the original was published. The American edition is an impression from the English types, and is most excellent in its execution. S.

4. *The Lens: A Quarterly Journal of Microscopy and the allied Natural Sciences;* with the Transactions of the State Microscopical Society of Illinois. Edited by S. A. BRIGGS. Publishing Committee: C. Biggs, E. H. Sargent, C. Adams. No. 1. 64 pp. 8vo. Chicago, January, 1872.—We have barely space to announce the appearance of the first number of this new scientific journal. While especially devoted to Microscopy, it will also include articles on other branches of natural science, especially those "illustrative of the Natural History of the Mississippi Valley and the Far West," together with notices of other publications and results. It states that its "aim is to be thoroughly scientific, advanced and comprehensive;" and it has made a good beginning in this direction in its first number.

5. *Elementary Treatise on Natural Philosophy;* by A. PRIVAT DESCHANEL. Translated and edited, with extensive additions, by J. D. EVERETT, M.A., D.C.L., F.R.S.E., in four parts of about 250 pp. each, 8vo. 1872. (D. Appleton & Co., New York.)—The publishers of this work have done the American public a good service in setting before it a book so well fitted for the general reader or student. The treatise is especially adapted for the use of those who desire to make themselves familiar with the general principles of Physics, but are not in a position to go into the mathematical difficulties of the subject. It is popular in style, though with no consequent lack of precision, and profuse and unsurpassed in its illustrations. The explanations and descriptions are clear and concise. The English editor has largely increased the value of the original work by the additions he has made.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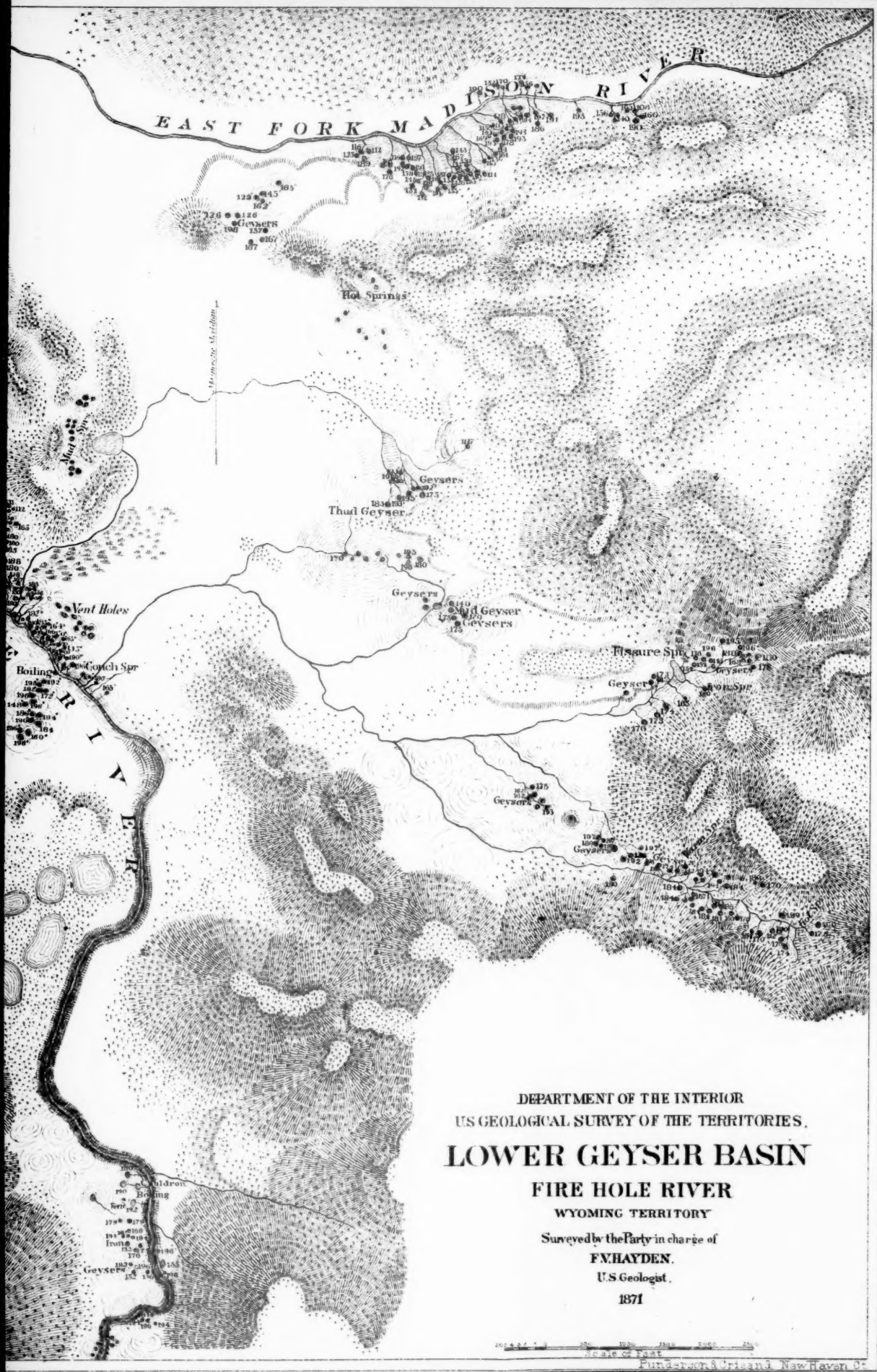
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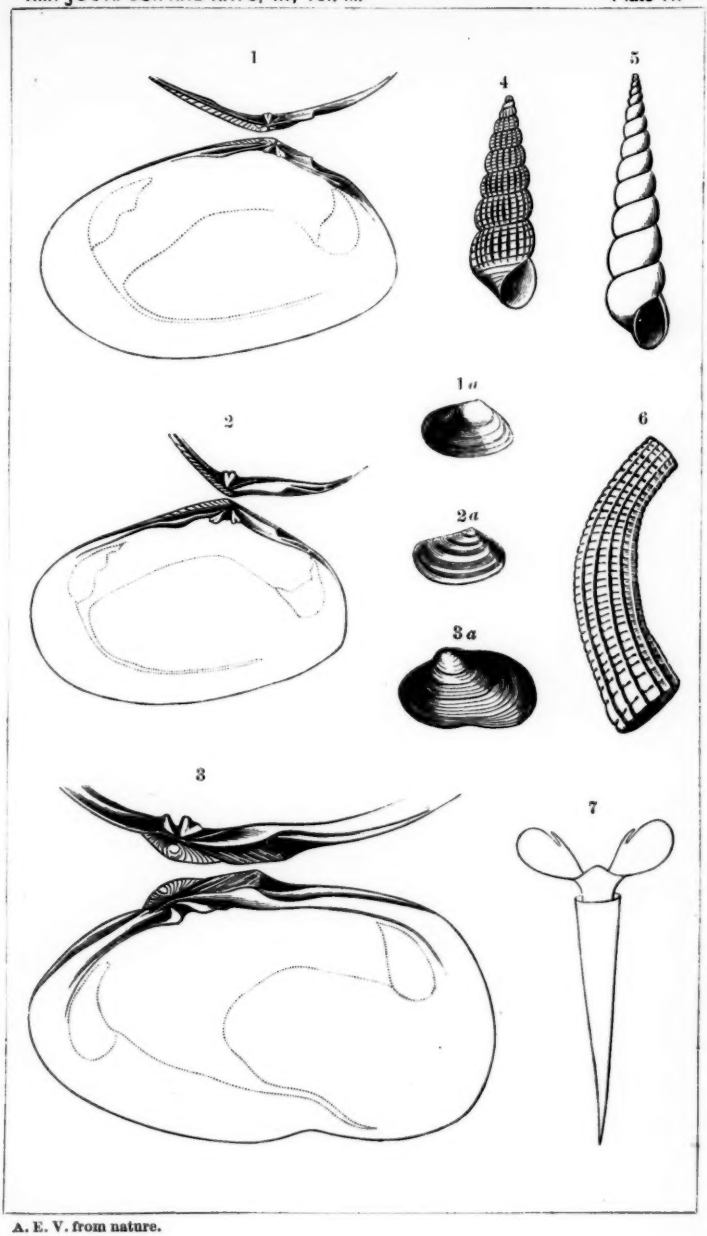

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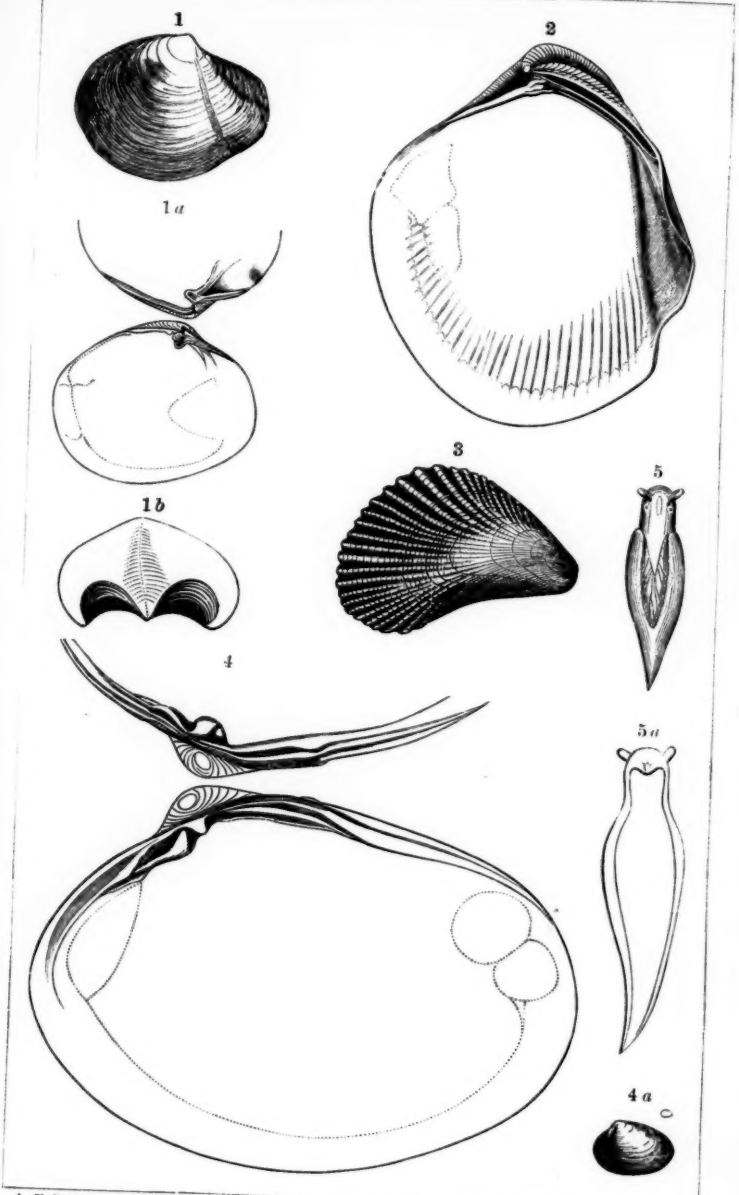

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